

Federal Register

**Thursday
March 10, 1983**

Part II

Department of Transportation

**Research and Special Programs
Administration**

**Requirements for Transportation of
Radioactive Materials**

DEPARTMENT OF TRANSPORTATION**Research and Special Programs Administration**

49 CFR Parts 171, 172, 173, 174, 175, 176, 177, and 178

[Docket No. HM-169; Amdt. Nos. 171-71, 172-78, 173-162, 174-42, 175-26, 176-15, 177-57, 178-75]

Requirements for Transportation of Radioactive Materials

AGENCY: Materials Transportation Bureau (MTB), Research and Special Programs Administration, DOT.

ACTION: Final rule.

SUMMARY: This final rule revises requirements of the Hazardous Materials Regulations concerning radioactive materials to make them compatible with the latest revised international standards for transport of radioactive materials as promulgated by the International Atomic Energy Agency (IAEA). A parallel amendment by the U.S. Nuclear Regulatory Commission (NRC), to Title 10 CFR Part 71, "Packaging of Radioactive Materials for Transport and Transportation of Radioactive Materials Under Certain Conditions" will be published in the *Federal Register* at a future date.

EFFECTIVE DATE: July 1, 1983, unless otherwise specified by the regulations adopted under this rulemaking, except for revised proper shipping names and identification numbers appearing in § 172.101 which may be used immediately, and except for §§ 173.415, 173.425 (b) and (c), 173.441(c), 173.477(b) and 173.478 (b) and (c) which contain information collection requirements which are under review at OMB. This effective date may be extended depending on the publication and effective date of corresponding amendments to 10 CFR, Part 71, by the Nuclear Regulatory Commission.

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SUPPLEMENTARY INFORMATION:**I. Background**

In keeping with MTB's commitment to maintain harmony between the international and U.S. regulations for the transportation of hazardous materials, this docket changes the requirements pertaining to radioactive materials. These changes will ensure essential uniformity between the Hazardous

Materials Regulations dealing with radioactive materials and the latest international regulations, the International Atomic Energy Agency's (IAEA) "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)." Detailed information of the U.S. participation in the development of these international regulations was given in the preambulatory text of the notice of proposed rulemaking (NPRM) for this docket (44 FR 1852, January 8, 1979).

Since certain aspects of the transportation of radioactive materials are regulated by the NRC, changes in their regulations necessary to maintain compatibility will be published in the future in the *Federal Register*. Those changes to 10 CFR Part 71 will deal with Type B and fissile radioactive materials packages and NRC licensee requirements.

The NPRM for this docket contained several proposed requirements which met with substantial objection by the commenters. In some cases a review of the costs and safety benefits involved has resulted in either modification or deletion of the proposed requirement. In another case, a provision has been made to eliminate unnecessary duplicative requirements for import and export shipments which must meet both DOT and IAEA requirements.

II. Substantive Changes

The first four of the substantive changes adopted in this amendment follow closely the proposed requirements in the notice. The other substantive changes are either modified versions of the proposed requirements or are new. Any new changes included here have been determined to have a very positive effect on reducing the cost of complying with the regulations with no adverse effect on transportation safety.

A. Individualized Type A Quantities

The system by which radionuclides have been divided, for the purpose of specifying the number of curies permitted in Type A packages, into seven transport groups according to their radiotoxicity has been eliminated. Under the previous system, the allowable number of curies for each radionuclide in a group or radionuclides is the same as the allowable number of curies for the most restrictive radionuclide. In some cases the least restrictive nuclides have a maximum permissible body burden more than ten times that of the most radiotoxic members.

The amendments have deleted the concept of transport groups. Instead, for

each radionuclide two values, A_1 and A_2 , are assigned which represent the maximum number of curies permitted in Type A packages in special form and normal form, respectively. The A_1 and A_2 values for various radionuclides are listed in § 173.435. Methods by which these values were established are described in IAEA Safety Series No. 37, "Advisory Material for the Application of the IAEA Transport Regulations."

The value of A_1 for special form material is based on the possible external radiation dose to individuals if the contents of the package are released, except that an upper limit of 1,000 curies is imposed. Under the revised regulations, special form material must also be nondispersible, as determined by certain stringent criteria (which differ somewhat from present criteria for special form) described in § 173.469.

The bases for the A_2 value for normal form material (that is, all forms other than special form) are: (1) an accident of moderate severity might release 0.1% of the contents of a Type A package, and 0.1% of the amount released might then be taken into the body of a human being in the vicinity; this intake should not exceed half the maximum permissible annual intake for workers as given in IAEA Safety Series No. 9, 1967 Edition; and (2) A_2 shall not exceed A_1 . Intake values are based on International Commission on Radiological Protection (ICRP) 1966 recommended limits for radiation exposure. It is expected that the IAEA will be producing new A_1 and A_2 values based on the latest ICRP data and models and these will be published at a later date for comment.

This change will sometimes permit a single Type A package to replace two or more present packages. Also, some of the small Type B packages with contents near the lower limit for Type B could be reclassified as Type A. The net effect of this clarification is expected to be insignificant with respect to the number of Type A packages or the total amount of material in Type A packages.

For special form material, some limits are increased and some are decreased. As a result of a number of comments, the previously specified value has been retained for americium and plutonium contained in special form americium-beryllium or plutonium-beryllium neutron sources or in nuclear-powered pacemakers which will not be exported. There are a large number of special form sources in existence which were fabricated to the 20 curie limit and have been safely transported in Type A packages. It is believed that the expense involved in transporting these sources in Type B packages or replacing them with sources of lower content is not justified

in light of the marginal safety gains. Consequently, for domestic shipments the existing 20 curie limit is retained for these types of neutron sources. For import and export shipments, however, the IAEA limits, which are lower, have been adopted to foster compliance with the IAEA regulations which are applied in all other major countries. The exception for domestic special form neutron sources is found in § 173.435, footnote 1. Consequently, the changes in the number of such packages should be small.

B. Requirements for Special Form Radioactive Material

The qualification tests for special-form radioactive material have been modified, primarily by adding a bending test, providing more detailed instructions for the immersion or leaching procedure, and changing the maximum loss by leaching to 0.05 microcurie in each of two determinations rather than the present 0.005% by weight for a single determination. Long, slender objects are more likely to suffer bending under rough handling or accident conditions than are short or large-diameter objects. A minimum length of 10 centimeters and a minimum length-to-width ratio of 10 have been selected for application of the bending test. The leaching test specified by the IAEA regulations has been selected as suitable and should yield uniform results. An absolute amount of activity leached is better related to the hazard than is a fixed percentage of weight. Although 0.05 microcurie is much smaller than any of the A_1 quantities, in this case it is specified as a measure of the indispersibility and is equivalent to the maximum permissible nonfixed surface contamination on 500 square centimeters of a package surface.

Previous regulations required that "special form radioactive material" have either: (1) No dimension less than 0.5 millimeters, or (2) at least one dimension greater than 5 millimeters. It is now required that special form radioactive material must have at least one dimension not less than 5 millimeters. The first option has been removed because of the possible difficulty of identifying, for safe handling, an object as small as 0.5 millimeters in every dimension.

The proposed definition for special form would have required all encapsulations to be "so constructed that it can be opened only by destructive means." This phrase was intended to clarify the IAEA requirement which states that an encapsulation must be "so constructed that it can be opened only by destroying

the capsule". Comments received indicated that IAEA wording was less subject to varying interpretations and so it has been incorporated in the definition of special form. Commenters pointed out some difficulties which would result from performing cutting and welding or brazing operations in the closed environment of a glove-box or hot cell, but these objections were not quantified to any degree and are routinely performed in certain industries. It was not established by the commenters that the proposed requirement could not be met or that it would be too costly to meet the requirement.

An option has been added to the requirements dealing with leak testing of special form capsules. The proposal only specified a leaching assessment method whereby the test specimen is immersed in water and stored in air with subsequent water immersion. The activity leached by the water immersion determines if the source is leakfree. As an option to this test, which takes over one week, a volumetric leak rate of 10^{-4} torr-liter/second for solids and 10^{-6} torr-liter/second for liquid and gaseous contents is specified as being equivalent to passing the leaching test. However, this volumetric leak test is only suitable for sources with an internal void volume of at least 0.10 milliliter and is restricted to these source designs. Providing this optional acceptance criteria allows the tester to utilize a number of different testing methods which are sensitive enough to detect volumetric leak rates of this magnitude.

A phase out period of two years has been provided in § 173.403(z) for special form capsule designs which are not requilified under the special form requirements in order to provide for the construction of additional capsules to existing designs. These capsules may continue to be transported to the end of their useful life. Two years following the effective date of this publication all new designs and all new construction must meet the current requirements.

C. Addition of Lead-201

In response to a petition for rulemaking by Diagnostic Isotopes, Inc., to the NRC, lead-201 (201-Pb) is added to the table of radionuclides found in § 173.435. The daughter radionuclide resulting from the decay of 201-Pb is thallium-201 which is useful in nuclear medicine and clinical diagnosis. The details of the calculations for the A_1 and A_2 values for 201-Pb are found in Appendix B of the Environmental Impact Appraisal of Changes to Radioactive Material Packaging and

Transportation Regulations, prepared by the NRC.

D. Metrication

The metric system, as represented by the International System of Units (SI), has been employed to the extent practicable in the revised regulations. Rounded-off values of equivalents for the English system are given in parentheses, except in a few cases where the conversion seems unnecessary or inappropriate. In some cases conventional units have been retained to prevent the confusion which would result from using SI units which are used very little as of this date, e.g., the millirem is retained instead of converting to Sieverts.

E. Low Specific Activity (LSA) Materials and Low Level Solid (LLS) Materials

The proposed regulations for LSA and LLS were in accord with the 1973 IAEA regulations in many regards but would have imposed more stringent packaging requirements. Many commenters objected to the increased costs which would have been incurred in upgrading or phasing out many existing package designs. Several commenters were of the opinion that more stringent packaging requirements and the associated costs would not significantly improve the safety of these materials in transportation.

Additionally, the NRC, with MTB cooperation, is studying the regulatory requirements and basis for LSA and LLS materials. This study is addressing the hazards, packaging requirements and costs involved in shipping these materials.

The IAEA has proposed an extensive revision of the LSA and LLS requirements including the imposition of additional radiation level limitations and more stringent packaging. These proposals are not expected to be adopted before mid-1984.

As a result of these current activities concerning LSA, MTB believes that the most prudent course of action is to make no substantive changes in the LSA packaging requirements at this time. Subsequently, the packaging requirements and any other identified concerns pertaining to LSA will be addressed in a future rulemaking. Consequently, this HM-169 final rule is greatly simplified over its proposal as many LSA requirements which were proposed have been deleted including the LLS category and such defined terms as the "transport index for low specific activity material or low level solid material transported as a full load. . . ."

The definition of LSA materials has been modified since the transport group system of radionuclide classification has been replaced by the A_1/A_2 system. LSA materials which are not specifically listed by name are classified according to the A_2 value for the nuclide or nuclides present in the LSA. For uniform mixtures of nuclides the following formula will determine if the mixture is defined as LSA:

$$\frac{APG_1}{0.0001} + \frac{APG_2}{0.005} + \frac{APG_3}{0.3} < 1$$

Where:

APG_1 = the total activity per gram of material of all nuclides present with an A_2 value of less than 0.05 curie.

APG_2 = the total activity per gram of material of all nuclides present with an A_2 value of more than 0.05 but less than 1.0 curie.

APG_3 = the total activity per gram of material of all nuclides present with an A_2 value exceeding 1.0 curie.

If the above summation for a given uniform mixture is less than or equal to 1 then the mixture may be classified as LSA.

The breakpoint values of 0.05 and 1.0 curie have been chosen to maintain as closely as possible the results obtained using the old transport group system with those obtained under the A_1/A_2 system.

F. Empty Packaging

A modification has been made to the provisions for shipping radioactive materials packagings which have been emptied of contents but still contain some residual material. Previously, § 173.29(b) prescribed the conditions under which packages could be shipped as "empty." These requirements in many respects were the same as for "limited quantities," that is, no significant external contamination and no radiation levels exceeding 0.5 millirem per hour at the packaging surface. In keeping with the excepted nature of these empty packagings the total residual radioactivity with the packaging was not to exceed a limited quantity as previously specified in § 173.391(a).

This presented a serious problem to shippers of these packagings in that in many instances it is not practical to determine the exact amount of residual radioactive material in the packaging. This is particularly true when the internal contamination is a combination of removable and fixed contamination. The removable constituents can be quantified by smear or wipe sampling but the fixed contamination is extremely difficult to quantify accurately unless the exact radionuclide mix is known. Consequently, there were only a few

instances when it was possible to ship packages as empty.

The IAEA has adopted criteria for empty packages which eliminate this problem, while still ensuring that these packages represent no significant hazard during transportation, by placing limits on the:

- (1) Removable external surface contamination;
- (2) Removable internal contamination; and,
- (3) Radiation level at the external surface of the packaging.

These three controls make it unnecessary to limit the total radioactivity present per se. The removable contamination limits ensure safety in handling and limit consequences in the event the packaging is damaged or opened. The radiation level limits ensure that exposures are extremely low and effectively places a limit on the amount of fixed contamination that may be present.

MTB believes that the IAEA criteria, as adopted in § 173.427, will provide for the continued safe shipping of empty packagings while providing needed flexibility in making these shipments.

G. Import/Export Shipments

Section 171.12 has been revised to permit the shipment of radioactive materials packages, in international commerce, which conform with the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition" (as amended) with certain restrictions. Prior to this amendment, such provisions were only available to packages not exceeding a Type A quantity, low specific activity radioactive materials, and non-fissile radioactive materials. Extending this authorization to fissile radioactive materials and shipments requiring a Type B packaging will greatly facilitate the through movement of these packages by reducing the administrative burden on shippers and carriers to comply with varying requirements between the U.S. and the international community, without a sacrifice in safety. However, certain requirements designed to aid in emergency response activities do remain—detailed shipping papers and placarding for "highway route controlled quantities" (see H., below) for example. In addition, for a shipper to qualify under this section its packages must be certified as being approved for use by the country of origin and foreign-designed packages must be revalidated or endorsed by MTB as is already required. This certification process addresses activity limits, authorized contents, suitability of package design,

special handling controls, and other areas which focus on the acceptability of packages for shipment, thereby assuring their ability to safely contain radioactive materials in transport. The MTB revalidation procedure is being maintained in order to ensure essentially equivalent levels of safety between import shipments and domestic shipments. MTB believes that this change will not decrease safety in any way because many of the differences still existing between the 1973 IAEA regulations and this rulemaking result from the IAEA regulations being too restrictive or imposing what MTB believes to be unnecessary requirements. One example is large freight container placarding. The U.S. regulations require placarding only under the three conditions presented in § 172.504, Table 1. The IAEA requires large freight container labeling and placarding for all radioactive materials except for limited quantities. However, in cases like this it is believed that there is no detriment in displaying the labels and placards and the provisions of § 171.12 relieve a significant burden on the shipper who otherwise must add or remove placards and labels at the border. The other existing differences between the U.S. and IAEA regulations are of a similar nature and allowing import and export shipments to move with minimal delay and expense with no detrimental effect on safety is believed to be in the public interest.

H. Designation of Highway Route Controlled Quantities

The adoption of the A_1/A_2 system to replace the transport group system of classifying radionuclides has removed the basis on which the term "large quantity" (§ 173.389(b)) was defined. The term "large quantity" was originally used to: (1) designate quantities of radioactive materials which generate sufficient decay heat to warrant consideration of heat dissipation in the package design and approval; and (2) identify packages whose contents are sufficient to require supplemental operational controls such as periodic venting of pressure or use of an active cooling system. This concept was embodied in the 1961, 1964 and 1967 IAEA transport regulations. Consequently the term was still in the Hazardous Materials Regulations as a vestige of the earlier IAEA versions.

Present practice in the U.S. is that all Type B packages are approved for specified contents and are limited to these specific contents. Decay heat rejection is one of the considerations taken into account in approving the

contents for a package design. This is a superior approach to the earlier, somewhat arbitrary establishment of "across the board" large quantity designations because decay heat rejection is in fact a contents and package dependent consideration. For example, a relatively small heat source could be thermally degraded if the package was an extremely good insulator and did not allow the generated heat to be rejected. Current practice in the U.S. is in line with the current (1973) IAEA approach which is to consider heat removal in all Type B package approvals.

The use of operational controls is another concept which has essentially been abandoned in the U.S. as well as world-wide. Current practice is to require that the package itself be capable of maintaining its integrity and meeting the hypothetical accident conditions without human intervention.

As a result of the evolution of the package approval process over the last 15 years the concept of a "large quantity" package design is now superfluous as it pertains to Type B package designs, approvals, and contents limitations. Currently, all Type B package designs meet the criteria which were, at one time, required only for high activity content packages.

The only remaining use for the term "large quantity" has been as a result of Docket HM-164 (46 FR 5298, January 19, 1981) which established rules governing the highway routing of radioactive materials shipments. Any vehicle transporting a Type B package containing a "large quantity" of radioactive materials is subject to additional requirements including specific routing criteria. Obviously, some provisions must be made for the continuity of this rule, a fact that was noted at the time the HM-164 rule was proposed (See 45 FR 7132, January 31, 1980) as well as when the final HM-164 rule was published (See 46 FR 5298, January 19, 1981).

The MTB, in conjunction with the NRC, has selected new criteria based on the A_1/A_2 system which will duplicate the "large quantity" criteria as closely as practical. The criteria selected also reflect some of the IAEA criteria for determining which shipments shall be subjected to additional administrative controls. The following criteria determine whether a particular amount of radioactive material within a single package shall be subjected to the additional administrative controls required by the HM-164 rules:

(1) $3,000 \times A_1$ for special form material;

(2) $3,000 \times A_2$ for normal form material; or

(3) 30,000 curies, whichever is least.

For any particular radionuclide or mixture, these values correspond to 3,000 times the contents permitted in a Type A package, or in the case of nuclides with an A_1 or A_2 (as appropriate) value of more than 10 curies, a designation of 30,000 curies as the value. In order to make these values as easy to understand and use as possible, the term "highway route controlled quantity" has been adopted. MTB believes that the term avoids confusion with the previously used term "large quantity" which means different things to different people and which is now obsolete.

There are some differences between the old values for "large quantity" and the new values for "highway route controlled quantity." The most significant differences occur for special form materials and alpha-emitting transuranic elements. For most special form materials, the new values are higher than the old value of 5,000 curies. This reflects the fact that the new values are directly related to the radiation source strength rather than an "across-the-board" value based on decay heat generation. The majority of special form shipments which will be relieved from specific routing requirements are medical and industrial shipments of cobalt-60 and cesium-137 irradiation sources. These sources typically fall into the range of 5,000-10,000 curies and are used in a variety of medical and industrial applications where medium strength sources are needed. It should be noted that while these sources are of significant activity when compared to "normal form" values, special form materials are essentially nondispersible. The integrity of the sources is high since the capsules themselves must be capable of withstanding severe accident conditions (30 foot drop, 1,475°F heat, percussion and immersion). This provides what is essentially a "Type B within a Type B" package, thus ensuring an extremely high level of integrity. Of the 140 shipments reported to MTB by October 31, 1982, as required by § 173.22(c), 42 of these would be relieved from the HM-164 routing and reporting requirements. The MTB believes this is a justified reduction of costs and delays given the integrity of the materials and in some cases the time-critical nature of the shipments. It should be noted that no irradiated reactor fuel is expected to fall into this category and be relieved from these requirements.

For some normal form alpha-emitting nuclides the new A_2 values are lower than the old 20 curie limit for Transport

Group I nuclides. There are 9 of these nuclides which will have lower highway route controlled quantities than before and some additional shipments of these materials would be subjected to the HM-164 requirements. Except for the thorium and plutonium nuclides, the affected nuclides which have lower values are not frequently shipped and the effect of lowering the values will be very small. For the thorium and plutonium isotopes, the result of the new values will also be small because these nuclides are generally shipped in mixtures which are very high in activity and will simply continue to be covered by HM-164 requirements or are in forms which are of such low specific activity that they are not covered under either the new or old criteria.

There are some shipments of normal form materials which have been reported to MTB which would be relieved from HM-164 requirements and these can be characterized as research related. These materials are generally mixtures destined for analysis or further research and generally fall into the range of 20 to 1,000 curies. The number of these shipments is low by virtue of their nature.

The MTB is convinced that the new highway route controlled quantities are superior to the old large quantity values for the purpose of HM-164 requirements. The new values more accurately reflect a uniform level of hazard for the contents. It is recognized that while some values will go higher and some will be lower, the net result will be a positive safety benefit and more accurately relates the package contents to the additional administrative controls imposed by HM-164.

III. Minor Changes

A. Marking of Limited Quantities and Devices

The Notice contained proposals concerning marking limited quantities and devices as required by the 1973 IAEA regulations. Several commenters objected to this, basically for two reasons:

(1) For limited quantities, the proposal that the packaging bear the marking "Radioactive" in such a manner as to be visible upon opening would require marking in several places since the shipper has no control over how the package is opened; and

(2) For radioactive devices, it is highly impractical to mark many devices (such as electron tubes) which contain minute amounts of radioactive material.

The MTB agrees with these comments and has removed the proposed marking

requirements for these materials, retaining the previously existing marking requirements (§ 173.391(a)) which are reasonable. Export or import shipments which need to comply with the 1973 IAEA regulations may be so marked and exported or imported in accordance with § 171.12(e).

B. DOT Specification 55 Packaging

As amended herein, the use of existing DOT Specification-55 (Spec 55) packages will be discontinued two years after the effective date of these amendments. As a result of prior rulemaking in Docket HM-111 (39 FR 45238), published on December 31, 1974, construction of Spec. 55 packages after March 31, 1975, has not been authorized. As was stated in the preamble to the notice of proposed rulemaking in Docket HM-111 (39 FR 29483, October 25, 1973), the Department announced its intention to phase out the Spec. 55 as a "limited Type B" packaging at some later date. Future use of such packagings two years after the effective date of this amendment to Part 173 will be contingent upon the user either requalifying the package design as a DOT Specification 7A (for Type A shipments), using the existing Specification 55's in conjunction with DOT Specification 20 WC or 21 WC wooden or wooden/steel outer packagings, or having the packaging approved by the NRC. This change from the proposal will still result in the phase out of Specification 55 packagings per se but will allow their continued use when requalified, reapproved, or used in conjunction with 20 WC and 21 WC outer packaging. The existence of these options significantly reduce the cost of this discontinuance and yet will ensure that the Spec 55's will meet the performance standards required of all other packages in order to ensure public safety.

C. DOT Specification 7A Packaging

Since the tests required for Specification 7A packagings are somewhat different than the previously required tests, a two year period has been established for shippers to adapt to the new test requirements.

Existing packagings may continue to be used as long as they will meet the previously existing Specification 7A test requirements. New packagings may be constructed to existing designs for a period of two years from the effective date of the amendment. The provisions allow for the continued use of existing packagings throughout their useful life and allows construction of new packagings to the "old" designs for two years.

Two years following the effective date of this publication all new packaging designs and all new packaging construction must meet the requirements of § 173.350 adopted herein and, consequently, the test requirements of § 173.465.

D. Labeling Requirements

In keeping with MTB's objective of simplifying and clarifying the regulations whenever possible, § 172.403 has been rewritten to include a table for use in determining the proper label to place on radioactive materials packages. The requirements pertaining to labeling have not been changed but the tabular presentation is believed to be an improvement over the previous text.

E. Redesignation of Subpart I in Part 173

Although the notice of proposed rulemaking considered reissuance of the radioactive materials regulations in a new Part 127 it has subsequently been determined to retain these requirements in Part 173, but in a separately identified subpart. Subpart I is the most logical choice since the regulations pertaining to radioactive materials will retain their same relative position in the Hazardous Materials Regulations with respect to the other hazard classes, and since the Special Requirements for Certain Rail Shipments or Movements will have greater visibility in Subpart A. Consequently, §§ 173.426 and 173.432 are recodified at §§ 173.9 and 173.10, respectively. The heading of Subpart I is changed to read "Radioactive Materials."

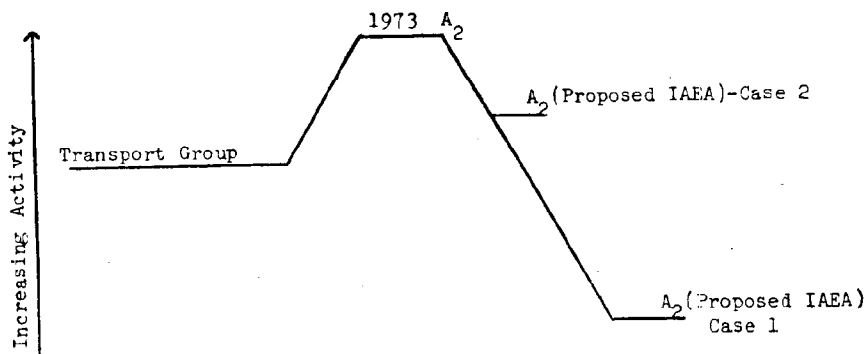
F. Type A Limits for Certain Beta-Emitting Radionuclides

The IAEA, as part of its effort to maintain the continued adequacy of the regulations, has adopted a modified system for determining A_1 and A_2 values. This new system will be incorporated in the 1984 revision of the IAEA regulations which is being

prepared. The system was adopted in principle by the IAEA at the March 1982, Advisory Group on the revision and it was subsequently refined by a special Working Group which met in August 1982. When the IAEA circulates the "3rd Draft" version of the regulations, DOT will be making it available and will seek public comment.

It has become apparent to MTB that the new system incorporates a radiological exposure pathway which has not been considered previously. This pathway involves consideration of the dose to the skin of a person contaminated with a radionuclide. For most radionuclides this is not a limiting pathway as other considerations in both the present and proposed systems are generally more limiting. Examples of the other more limiting considerations are radiation levels from unshielded material and internal pathways such as inhalation. For some beta-emitting nuclides, however, the contaminated skin consideration is limiting. In some cases the Type A limits calculated under the newly adopted system are significantly lower than the previously accepted A_2 values and some are even lower than the earlier Transport Group values.

The MTB believes that it cannot ignore the contribution that the contaminated skin consideration makes toward a complete system for calculating Type A values. This is particularly true for radionuclides which have high A_2 values under the 1973 IAEA regulations and would have considerably lower A_2 values under the new IAEA system due to their potential for significant dose to contaminated skin. Of the radionuclides which would have lower values under the new IAEA system, some have values below the old transport group values (case 1) and some have values between the old transport group and the 1973 IAEA values (case 2). These two cases can be represented graphically as:



The MTB believes that it is prudent to both accept this new pathway as necessary to provide a complete system for setting Type A values and to minimize unnecessary fluctuations in the Type A limits. While there is some uncertainty as to the exact values which will result from the final, accepted new IAEA system the MTB is confident that the values now available are conservative and will most probably not be lowered. Therefore, for those nuclides which are limited by the skin exposure pathway values have been selected as follows:

Case 1: The transport group values are adopted as the new A_2 values.

Case 2: The values now available are adopted in lieu of the 1973 IAEA values.

The radionuclides which are affected in case 1 are:

Ag-111	Nd-147	Si-31
As-77	Nd-149	Sm-153
Au-198	Os-193	Te-127M
Cd-115	Pd-109	Te-127
Ce-143	Pm-149	Te-129
Dy-165	Pr-143	W-187
Er-171	Pt-197m	Zn-69m
Gd-159	Pt-197	Zn-69
In-115m	Re-186	
Mo-99	Sc-47	

The radionuclides which are affected in case 2 are:

Au-199	Eu-155	Rh-105
Br-77	Hf-181	Ru-103
C-14	Hg-203	S-35
Ca-45	I-133	Sb-125
Ce-141	In-111	Sr-89
Cl-38	Ir-192	Tb-160
Cs-134m	K-43	Tc-99
Cs-135	La-177	Te-129m
Cs-137	N-13	Th-231
Cu-64	Np-239	Tl-204
Cu-67	O-191	Tm-170
Er-169	Pm-147	W-185
Eu-152	Rb-81	Yb-175

In both cases the values adopted herein are no lower than the previously existing transport group values and yet are lower than the previously proposed 1973 IAEA A_2 values. For the radionuclides listed under case 1, the A_2 is set at the old limit of 20 curies as each nuclide was previously in transport group IV which had this limit. The nuclides listed in case 2 have been assigned the currently available values under the new IAEA system. These values are between the old transport group and the 1973 IAEA values. When the new IAEA system is fully implemented by the IAEA and the skin exposure pathway is taken into due account then MTB expects to complete the alignment of A_2 values between the U.S. and the IAEA.

IV. Classification of Rule; Reporting Requirements; and Impact on Small Entities

A. Non-major rule

The Materials Transportation Bureau has determined that this regulatory amendment is not a major rule under terms of Executive Order 12291 or significant under DOT regulatory procedures (44 FR 11034) and does not require a Regulatory Impact Analysis, nor does it require an environmental impact statement under the National Environmental Policy Act (42 U.S.C. 4321 et. seq.).

This determination is made on the basis that: (1) The final rule will have an annual effect on the economy not exceeding \$100 million, (2) there will be no major increase in costs or prices for consumers, individual industries, Federal, State, or local governmental agencies, or geographic regions, and (3) it will not result in significant adverse effects on competition, employment, investment, productivity, innovation, or the ability of U.S.-based enterprises to compete with foreign-based enterprises in domestic or export markets.

The Department has determined under Council of Environmental Quality guidelines not to prepare an environmental impact statement for the amendment herein.

Concurrently with the publication of this rulemaking document, the Department is making available in its Dockets Branch at the address indicated above, an "Environmental Impact Assessment of Changes to Radioactive Materials Transport Regulations" intended to support a negative declaration. This assessment was prepared by the U.S. Nuclear Regulatory Commission in support of its changes to 10 CFR Part 71 which are to be published in a subsequent issue of the *Federal Register*. Its analyses and conclusions are considered directly applicable to the proposals by the Department herein, in support of this negative declaration.

B. Paperwork Reduction Act

In accordance with the Paperwork Reduction Act of 1980 (P.L. 96-511), certain reporting or recordkeeping provisions that are included in this regulation have been submitted for approval to the Office of Management and Budget (OMB). They are not effective until OMB approval has been obtained and the public notified to that effect through a technical amendment to this regulation. Other information collection requirements contained in this regulation (§§ 173.471 (a), (d), and (f), 173.472 (b) and (e), 173.473(a), 173.476 (a)

and (b), and 173.478(a)) have been approved by OMB and assigned control numbers indicated in the regulatory text of this document.

C. Impact on Small Entities

Based on limited information available concerning size and nature of entities likely to be affected, I certify that this amendment will not, as promulgated, have a significant economic impact on a substantial number of small entities. Small businesses potentially affected include manufacturers, distributors, carriers, and users of: (1) Radiopharmaceuticals; (2) measuring, detecting, and calibrating devices which employ radioactive materials; and (3) packagings specifically designed for use in the transportation of radioactive materials. The economic impact on such small entities will be minimal.

V. List of Subjects

49 CFR Part 171

Exports, hazardous materials transportation, Imports.

49 CFR Part 172

Hazardous materials transportation, Labeling.

49 CFR Part 173

Hazardous materials transportation, Packaging and containers.

49 CFR Part 174

Hazardous materials transportation, Railroad safety.

49 CFR Part 175

Hazardous materials transportation, Air carriers, Radioactive materials.

49 CFR Part 176

Hazardous materials transportation, Maritime carriers.

49 CFR Part 177

Hazardous materials transportation, Motor carriers.

49 CFR Part 178

Hazardous materials transportation, Packaging and containers.

In consideration of the foregoing, Parts 171, 172, 173, 174, 175, 176, 177, and 178 of Title 49, Code of Federal Regulations are amended as follows:

PART 171—GENERAL INFORMATION, REGULATIONS, AND DEFINITIONS

1. In § 171.7, paragraphs (c)(15), (d)(10) and (d)(11) are revised to read as follows, and paragraph (c)(25) is removed and reserved.

§ 171.7 Matter incorporated by reference.

(c) * * *

(15) IAEA: International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box 100, A-1400, Vienna, Austria

* * *

(25) [Reserved]

* * *

(d) * * *

(10) IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 8, 1973 Revised Edition (as amended)."

(11) United States Nuclear Regulatory Commission (USNRC) 10 CFR Part 71, "Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions."

* * *

2. In § 171.8, the entry for "full load" is removed, a definition for "IAEA" is added in its proper alphabetical sequence, and the following definitions are revised to read as follows:

§ 171.8 Definitions and abbreviations.

"IAEA" means International Atomic Energy Agency.

* * *

"Package" or "Outside Package" means a packaging plus its contents. For radioactive materials, see § 173.403 of this subchapter. "Packaging" means the assembly of one or more containers and any other components necessary to assure compliance with the minimum packaging requirements of this subchapter and includes containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank car tanks.

For radioactive materials, see § 173.403 of this subchapter.

* * *

"Preferred route" or "Preferred highway" is a highway for shipment of "highway route controlled quantities" of radioactive materials so designated by a State routing agency, and any Interstate System highway for which an alternative highway has not been designated by such State agency as provided by § 177.825(b) of this subchapter.

* * *

"Radioactive materials" See § 173.403 of this subchapter for definitions relating to radioactive materials.

* * *

2a. In § 171.11, paragraph (d)(6)(ii), is amended by removing section reference "§ 173.393(b)" and inserting in its place "§ 173.471, 173.472 and 173.473"; paragraph (d)(6)(iii) is amended by removing section reference "173.393 (p)(q) and (r)(3)" and inserting in its place "173.448 (e)(f) and (g)(3)"; paragraph (d)(6)(iv) is amended by removing section reference "§ 173.391" and inserting in its place "§§ 173.421, 173.422 or 173.424, as appropriate"; and paragraph (d)(6)(v) is revised to read as follows:

§ 171.11 Use of ICAO Technical Instructions.

(d) * * *

(6) * * *

(v) Type A package contents shall be limited in accordance with § 173.431 of this subchapter.

* * *

3. In § 171.12, paragraph (e) is revised to read as follows:

§ 171.12 Import and export shipments.

* * *

(e) Radioactive materials being imported into or exported from the United States, or passing through the United States in the course of being shipped between places outside the United States, may be offered and accepted for transportation when packaged, marked, labeled and otherwise prepared for shipment in accordance with IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)", if:

(1) The radioactive material is offered and accepted in accordance with the requirements of Subparts C and F of Part 172 of this subchapter pertaining to shipping papers and placarding;

(2) For fissile materials and Type B packages, the competent authority certification and any necessary revalidation is obtained from the appropriate competent authorities as specified in §§ 173.471, 173.472 and 173.473 of this subchapter; and all requirements of the certificates and revalidations are met;

(3) Type A package contents shall be limited in accordance with § 173.431 of this subchapter; and

(4) The country of origin for the shipment has adopted the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)."

PART 172—HAZARDOUS MATERIALS TABLES AND HAZARDOUS MATERIALS COMMUNICATIONS REGULATIONS

4. The Hazardous Materials Table to § 172.101 is amended as follows:

§ 172.101 Purpose and use of hazardous materials table.

* * *

§ 172.101 Hazardous Materials Table

(1) + EAW	(2) Hazardous materials descriptions and proper shipping names	(3) Hazard class	(3A) Identification number	(4) Label(s) required (if not excepted)	(5) Packaging		(6) Maximum net quantity in one package		(7) Water shipments		
					Excep- tions	Specific require- ments	Passenger carrying aircraft or railcar	Cargo only aircraft	Cargo ves- sel	Pass- enger vessel	Other require- ments
					(a)	(b)	(a)	(b)	(a)	(b)	(c)
Deletions.....											
Plutonium nitrate, solution	Radioactive Material.....	NA9185.....	Radioactive (See 172.403).	173.393	173.396				1,2.....	1,2	

(1) + EAW	(2) Hazardous materials descriptions and proper shipping names	(3) Hazard class	(3A) Identification number	(4) Label(s) required (if not excepted)	(5) Packaging		(6) Maximum net quantity in one package		(7) Water shipments		
					Excep- tions	Specific require- ments	Passenger carrying aircraft or railcar	Cargo only aircraft	Cargo ves- sel	Pass- enger vessel	Other require- ments
	Radioactive device, n.o.s.	Radioactive Material.....	UN2911.....	None.....	(a) 173.391	(b)	(a)	(b)	(a) 1,2	(b) 1,2	(c)
	Revisions										
	Radioactive material, empty packages.	Radioactive Material.....	UN2908.....	Empty.....	173.427				1,2	1,2	
	Radioactive material, fissile, n.o.s.	Radioactive Material.....	UN2918.....	Radioactive.....	173.453	173.417			1,2	1,2	
	Radioactive material, instruments and articles.	Radioactive Material.....	UN2911.....	None.....	173.422				1,2	1,2	
	Radioactive material, limited quantity, n.o.s.	Radioactive Material.....	UN2910.....	None.....	173.421				1,2	1,2	
	Radioactive material, low specific activity or LSA, n.o.s.	Radioactive Material.....	UN2912.....	Radioactive.....	173.421 173.422 173.424	173.425			1,2	1,2	
	Radioactive material, n.o.s.	Radioactive Material.....	UN2982.....	Radioactive.....	173.421 173.422 173.416 173.424	173.415			1,2	1,2	
	Radioactive material, special form, n.o.s.	Radioactive Material.....	UN2974.....	Radioactive.....	173.421 173.422	173.415 173.416			1,2	1,2	
	Thorium metal, pyrophoric.	Radioactive Material.....	UN2975.....	Radioactive and Flammable Solid.	None	173.418	Forbidden.....	2.5 pounds.....	1,2	1,2	
	Thorium nitrate.....	Radioactive Material.....	UN2976.....	Radioactive and Oxidizer.	None	173.419	Forbidden.....	25 pounds.....	1,2	1,2	Separate longitudi- nally by a complete hold or compart- ment from explosives.
	Uranium hexafluoride, fissile (containing more than 0.72% U-235).	Radioactive Material.....	UN2977.....	Radioactive and Corrosive.	173.453	173.417			1,2	1,2	
	Uranium hexafluoride, low specific activity.	Radioactive Material.....	UN2978.....	Radioactive and Corrosive.	173.421	173.425			1,2	1,2	
	Uranium metal pyrophoric.	Radioactive Material.....	UN2979.....	Radioactive and Flammable solid.	None	173.418	Forbidden.....	Forbidden.....	1,2	1,2	
E	Uranyl acetate (RQ- 5000/2270).	Radioactive Material.....	NA9180.....	Radioactive.....	173.421	173.415			1,2	1,2	
E	Uranyl nitrate hexahydrate solution (RQ-5000/ 2270).	Radioactive Material.....	UN2980.....	Radioactive and Corrosive.	173.421 173.425	173.415 173.416 173.417			1,2	1,2	
E	Uranyl nitrate, solid (RQ-5000/2270).	Radioactive Material.....	UN2981.....	Radioactive and Oxidizer.	None	173.419	Forbidden.....	25 pounds.....	1,2	1,2	Separate longitudi- nally by an inter- vening hold or compart- ment; from explosives.

5. In § 172.203, paragraph (d)(1)(i) is amended by removing section reference "§ 173.390" and inserting in its place "§ 173.435"; paragraph (d)(1)(vi)(A) is amended by removing section reference "§ 173.396(a)" and inserting in its place "§ 173.453"; paragraph (d)(1)(vi)(B) is amended by removing section reference "§ 173.389(a)" and inserting in its place "§ 173.455"; paragraph (d)(1)(vii) is amended by removing the phrases "U.S.

Energy Research and Development Administration (ERDA)" and "ERDA", and inserting in their appropriate place "U.S. Department of Energy (DOE)" and "DOE", and by removing section reference "§ 173.393a" and inserting in its place "§ 173.471"; paragraph (d)(1)(viii) is amended by removing section reference "§ 173.393b(a)(3)" and inserting in its place "§ 173.473"; paragraph (d)(1)(ix) is removed; and the

last sentence of paragraph (d)(1)(iii) is amended to read as follows:

§ 172.203 Additional description requirements.

* * *

(d) * * *

(1) * * *

(iii) * * * For the shipment of a package containing a highway route controlled quantity of radioactive

materials (see § 173.403(1) of this subchapter), the words "Highway route controlled quantity" must be entered in association with the basic description.

§ 172.204 [Amended]

6. In § 172.204, paragraph (c)(4) is amended by removing section reference "§ 173.391(a)(b) or (c)" and inserting in its place "§§ 173.421, 173.422, 173.424."

§ 172.310 [Amended]

7. In § 172.310, paragraph (a)(2) is amended by removing section reference "§§ 173.389(j) and (k) and 173.398(b) and (c)" and inserting in its place "§ 173.403"; and paragraph (a)(3) is amended by removing section reference "§§ 173.393a and 173.393b" and inserting in its place §§ 173.471, 173.472, and 173.473."

8. In § 172.400, paragraph (b)(10) is revised to read as follows:

§ 172.400 General labeling requirements.

(b) * * *

(10) Package of low specific activity radioactive material, when being transported in a transport vehicle assigned for exclusive use of the consignor under § 173.425(b) of this subchapter.

9. In § 172.403, paragraph (a) is amended by removing section reference "§ 173.391 or § 173.392" and inserting in its place "§§ 173.421 through 173.425"; paragraph (g)(1) is amended by removing section reference "§ 173.390" and inserting in its place "§ 173.435"; paragraph (g)(2) is amended by removing the phrase "Number of curies" and inserting in its place "Activity"; paragraph (g)(3) is amended by removing the section reference "§ 173.389(i)" and inserting in its place "§ 173.403"; paragraph (d) is removed and reserved; and paragraphs (b) and (c) are revised to read as follows:

§ 172.403 Radioactive material.

(b) The proper label to affix to a package of radioactive material is based on the radiation level at the surface of the package, the transport index (§ 173.403 of this subchapter) and, if appropriate, the fissile characteristics of the package. The proper category of label shall be determined in accordance with paragraph (c) of this section. The label to be applied shall be the highest category required for any of the three determining conditions for the package. Radioactive White-I is the lowest category and Radioactive Yellow-III is the highest. For example: a package with

a transport index of 0.8 and a maximum surface radiation level of 60 millirem per hour which contains no fissile material must bear a Radioactive Yellow-III label.

(c) Category of Label to be Applied to Radioactive Materials Packages:

Transport index (T.I.)	Radiation level at package surface (RL)	Fissile criteria	Label category. ¹
T.I.=0	RL<0.5 millirem per hour (mrem/h).	Fissile class I only, no fissile class II or III.	White-I.
T.I.<1.0	0.5 mrem/h < RL < 50	Fissile class I, fissile class II, with T.I.<1.0, no fissile class III.	Yellow-II.
1.0<T.I.	50 mrem/h < RL	Fissile class II with 1.0<T.I., fissile class III.	Yellow-III.

¹Any package containing a "highway route controlled quantity" (§ 173.403 of this subchapter) must be labeled as Radioactive Yellow-III.

(d) [Reserved]

§ 172.504 [Amended]

10. In § 172.504, footnote 5 to Table 1 is amended by removing section reference "§§ 173.389(c) and 173.389(o)" and inserting in its place "§ 173.403", and by removing section reference "§ 173.392(b)" and inserting in its place "§ 173.425(b)".

10a. Section 172.507 is revised to read as follows:

§ 172.507 Special placarding provisions: Highway.

Each motor vehicle used to transport a package of highway route controlled quantity radioactive materials (see § 173.403(l) of this subchapter) must have the required RADIOACTIVE warning placard placed on a square background as described in § 172.527.

§ 172.510 [Amended]

10b. In § 172.510, paragraph (d) is amended by removing section reference "173.426" and inserting, in its place, "173.9".

§ 172.527 [Amended]

10c. In § 172.527, paragraph (a) is amended by removing the term "large quantity" and inserting in its place "highway route controlled quantity".

PART 173—SHIPPERS—GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGINGS

§ 173.7 [Amended]

10d. In § 173.7, paragraph (d) is amended by removing section reference

"§§ 173.393a and 173.394 through 173.396" and inserting in its place, "§§ 173.416 and 173.417".

§ 173.22 [Amended]

10e. In § 173.22, paragraph (c) is amended by removing the phrase "large quantity packages of radioactive material (see § 173.389 of this subchapter)" and inserting in its place "highway route controlled quantity packages of radioactive materials (see § 173.403)"; and paragraph (d) is amended by removing the phrase "large quantity of radioactive material (see § 173.389(b))" and inserting in its place "highway route controlled quantity of radioactive material (see § 173.403(1))".

§ 173.29 [Amended]

11. In § 173.29, paragraph (b) is removed and reserved.

§ 173.121 [Amended]

11a. In § 173.121, paragraph (a)(6) is amended by removing section reference "173.432" and inserting in its place "173.10."

§ 173.123 [Amended]

11b. In § 173.123, paragraph (a)(5) is amended by removing section reference "173.432" and inserting in its place "173.10".

§ 173.226 [Reserved]

12. Section 173.226 is removed and reserved.

§ 173.389 through 173.398 [Reserved]

13. Sections 173.389 through 173.398 are removed and reserved.

§ 173.9 [Redesignated from § 173.426]

13a. Section 173.426 is transferred to Subpart A and redesignated as § 173.9.

§ 173.10 [Redesignated from § 173.432]

13b. Section 173.432 is transferred to Subpart A and redesignated as § 173.10.

14. Subpart I is revised to read as follows:

Subpart I—Radioactive Materials

Sec.

173.401 Scope.

173.403 Definitions.

173.411 General design requirements.

173.412 Additional design requirements for

Type A packages.

173.413 Requirements for Type B packages.

173.415 Authorized Type A packages.

173.416 Authorized Type B packages.

173.417 Authorized packaging—fissile materials.

173.418 Authorized packaging—pyrophoric radioactive materials.

173.419 Authorized packaging—oxidizing radioactive materials.

173.421 Limited quantities of radioactive materials.

Sec.

- 173.422 Exceptions for instruments and articles.
- 173.423 Table of activity limits—excepted quantities and devices.
- 173.424 Excepted article containing natural uranium or thorium.
- 173.425 Transport requirements for low specific activity (LSA) radioactive materials.
- 173.427 Empty radioactive materials packaging.
- 173.431 Activity limits for Type A and Type B packages.
- 173.433 Requirements for determination of A_1 and A_2 values for radionuclides.
- 173.435 Table of A_1 and A_2 values for radionuclides.
- 173.441 Radiation level limitations.
- 173.442 Thermal limitations.
- 173.443 Contamination control.
- 173.444 Labeling requirements.
- 173.446 Placarding requirements.
- 173.447 Storage incident to transportation—general requirements.
- 173.448 General transportation requirements.
- 173.451 Fissile materials—general requirements.
- 173.453 Fissile materials—exceptions.
- 173.455 Classification of fissile materials packages.
- 173.457 Transportation of Fissile Class III shipments—specific requirements.
- 173.459 Mixing of fissile material packages.
- 173.461 Demonstration of compliance with tests.
- 173.462 Preparation of specimens for testing.
- 173.463 Packaging and shielding—testing for integrity.
- 173.465 Tests for proposed packagings designed for normal conditions of transportation.
- 173.466 Additional tests for Type A packagings designed for liquids and gases.
- 173.467 Tests for demonstrating the ability of Type B and fissile radioactive materials packagings to withstand accident conditions in transportation.
- 173.469 Tests for special form radioactive materials.
- 173.471 Requirements for U.S. Nuclear Regulatory Commission approved packages.
- 173.472 Requirements for exporting DOT specification Type B and fissile packages.
- 173.473 Requirements for foreign-made packages.
- 173.474 Quality control for construction of packaging.
- 173.475 Quality control requirements prior to each shipment of radioactive materials.
- 173.476 Approval of special form radioactive materials.
- 173.477 Approval for export shipments.
- 173.478 Notification to competent authorities for export shipments.

Subpart I—Radioactive Materials**§ 173.401 Scope.**

(a) This subpart sets forth requirements for the transportation of radioactive materials by carriers and

shippers subject to this subchapter. The requirements prescribed in this subpart are in addition to, but not in lieu of, other requirements set forth in this subchapter and in 10 CFR Part 71 for the packaging and transportation of radioactive materials.

(b) This subpart does not apply to—

- (1) Radioactive materials produced, used, transported, or stored within an establishment other than during the course of transportation.
- (2) Radioactive materials contained in a medical device, such as a heart pacemaker, which is implanted in a human being or live animal.
- (3) Radiopharmaceuticals that have been injected into, or ingested by, and are still in human beings or live animals.

§ 173.403 Definitions.

In this subpart:

- (a) " A_1 " means the maximum activity of special form radioactive material permitted in a Type A package.
- (b) " A_2 " means the maximum activity of radioactive material, other than special form or low specific activity radioactive material, permitted in a Type A package. These values are either listed in § 173.435 or may be derived in accordance with the procedure prescribed in § 173.433.
- (c) "Closed transport vehicle" means a vehicle equipped with a securely attached exterior enclosure that during normal transportation restricts the access of authorized persons to the cargo space containing the radioactive materials. The enclosure may be either temporary or permanent, and in the case of packaged materials may be of the "see-through" type, and must limit access from top, sides, and ends.
- (d) "Containment system" means the components of the packaging intended to retain the radioactive contents during transportation.
- (e) "Conveyance" means any vehicle, aircraft, vessel, freight container, or hold, compartment or defined deck area of an inland waterway craft or seagoing vessel.
- (f) "Depleted uranium" means uranium containing less uranium-235 than the naturally occurring distribution of uranium isotopes.

(g) "Design" means the description of a special form material, a package, or a packaging, that enables those items to be fully identified. The description may include specifications, engineering drawings, reports showing compliance with regulatory requirements, and other relevant documentation.

(h) "Enriched uranium" means uranium containing more uranium-235 than the naturally occurring distribution of uranium isotopes.

(i) "Exclusive use" [also referred to in other regulations as "sole use" or "full load"] means the sole use of a conveyance by a single consignor and for which all initial, intermediate, and final loading and unloading are carried out in accordance with the direction of the consignor or consignee.

(j) "Fissile material" means any material consisting of or containing one or more fissile radionuclides. Fissile radionuclides are plutonium-238, plutonium-239, plutonium-241, uranium-233 and uranium-235. Neither natural nor depleted uranium are fissile material. Fissile materials are classified according to the controls needed to provide nuclear criticality safety during transportation, as provided in § 173.455. Certain exclusions are provided in § 173.453.

(k) "Freight container" means a reusable container having a volume of 1.81 cubic meters (64 cubic feet) or more, designed and constructed to permit being lifted with its contents intact and intended primarily for containment of packages in unit form during transportation. A small freight container is one which has either one outer dimension less than 1.5 meters (4.9 feet) or an internal volume of not more than 3.0 cubic meters (106 cubic feet). All other are designated as "large freight containers."

(l) "Highway route controlled quantity" means a quantity within a single package which exceeds:

- (1) 3000 times the A_1 value of the radionuclides as specified in § 173.433 for special form radioactive material;
- (2) 3000 times the A_2 value of the radionuclides as specified in § 173.433 for special form radioactive material; or
- (3) 30,000 curies, whichever is least.

(m) "Limited quantity of radioactive materials" means a quantity of radioactive material not exceeding the limits given in § 173.423.

(n) "Low specific activity material (LSA)" means any of the following:

- (1) Uranium or thorium ores and physical or chemical concentrates of those ores.

(2) Unirradiated natural or depleted uranium or unirradiated natural thorium.

(3) Tritium oxide in aqueous solutions provided the concentration does not exceed 5.0 millicuries per milliliter.

(4) Material in which the radioactivity is essentially uniformly distributed and in which the estimated average concentration per gram of contents does not exceed:

- (i) 0.0001 millicurie of radionuclides for which the A_2 quantity is not more than .05 curie;

(ii) 0.005 millicurie of radionuclides for which the A_2 quantity is more than .05 curie, but not more than 1 curie; or

(iii) 0.3 millicurie of radionuclides for which the A_2 quantity is more than 1 curie.

(5) Objects of nonradioactive material externally contaminated with radioactive material, provided that the radioactive material is not readily dispersible and the surface contamination, when averaged over an area of 1 square meter, does not exceed 0.0001 millicurie (220,000 disintegrations per minute) per square centimeter of radionuclides for which the A_2 quantity is not more than .05 curie, or 0.0001 millicurie (2,200,000 disintegrations per minute) per square centimeter for other radionuclides.

(o) "Multilateral approval" means approval by both the appropriate competent authority of the country of origin and of each country through or into which the shipment is to be transported. This definition does not imply approval from countries over which radioactive materials are carried in aircraft, if there is no scheduled stop in that country.

(p) "Natural thorium" means thorium with the naturally occurring distribution of thorium isotopes (essentially 100 weight percent thorium-232).

(q) "Natural uranium" means uranium with the naturally occurring distribution of uranium isotopes (approximately 0.711 weight percent uranium-235 and the remainder essentially uranium-238).

(r) "Non-fixed radioactive contamination" means radioactive contamination that can be readily removed from a surface by wiping with an absorbent material. Non-fixed (removable) radioactive contamination is not significant if it does not exceed the limits specified in § 173.443.

(s) "Normal form radioactive material" means radioactive material which has not been demonstrated to qualify as "special form radioactive material."

(t) "Package" means, for radioactive materials, the packaging together with its radioactive contents as presented for transport.

(u) "Packaging" means, for radioactive materials, the assembly of components necessary to ensure compliance with the packaging requirements of this subpart. It may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks. The vehicle, tie-down system, and auxiliary equipment may sometimes be designated as part of the packaging.

(v) "Radiation level" means the radiation dose-equivalent rate expressed in millirem per hour (mrem/h). Neutron flux densities may be converted into radiation levels according to Table 1:

TABLE 1.—NEUTRON FLUX DENSITIES TO BE REGARDED AS EQUIVALENT TO A RADIATION LEVEL OF 1 MILLIREM PER HOUR (MREM/H)¹

Energy of neutron	Flux density equivalent to 1 mrem/h (Neutrons per square centimeter per second)(n/cm ² /s)
Thermal.....	268.0
5 keV.....	228.0
20 keV.....	112.0
100 keV.....	32.0
500 keV.....	12.0
1 MeV.....	7.2
5 MeV.....	7.2
10 MeV.....	6.8

¹ Flux densities equivalent for energies between those listed above may be obtained by linear interpolation.

(w) "Radioactive article" means any manufactured device such as an instrument, clock, electronic tube or apparatus, or similar device having radioactive material as a component part.

(x) "Radioactive contents" means the radioactive material, together with any contaminated liquids or gases, within the package.

(y) "Radioactive material" means any material having a specific activity greater than 0.002 microcuries per gram ($\mu\text{Ci/g}$) (see definition of "specific activity").

(z) "Special form radioactive material" means radioactive material which satisfies the following conditions:

(1) It is either a single solid piece or is contained in a sealed capsule that can be opened only by destroying the capsule;

(2) The piece or capsule has at least one dimension not less than 5 millimeters (0.197 inch); and

(3) It satisfies the test requirements of § 173.469. Special form encapsulations designed in accordance with the requirements of § 173.389(g) in effect on June 30, 1983, and constructed prior to July 1, 1985 may continue to be used. Special form encapsulations either designed or constructed after June 30, 1985 must meet the requirements of this paragraph.

(aa) "Specific activity" of a radionuclide, means the activity of the radionuclide per unit mass of that nuclide. The specific activity of a material in which the radionuclide is essentially uniformly distributed is the activity per unit mass of the material.

(bb) "Transport index" means the dimensionless number (rounded up to

the first decimal place) placed on the label of a package to designate the degree of control to be exercised by the carrier during transportation. The transport index is determined as follows:

(1) The number expressing the maximum radiation level in millirem per hour at one meter (3.3 feet) from the external surface of the package; or

(2) For Fissile Class II packages or packages in a Fissile Class III shipment, the number expressing the maximum radiation level at one meter (3.3 feet) from the external surface of the package, or the number obtained by dividing 50 by the allowable number of packages which may be transported together, whichever is larger.

(cc) "Type A package" means a Type A packaging together with its limited radioactive contents. A Type A package does not require competent authority approval, since its contents are limited to A_1 or A_2 .

(dd) "Type B package" means a Type B packaging together with its radioactive contents.

(ee) "Type B(M)" means a Type B packaging, together with its radioactive contents, that for international shipments requires multilateral approval of the package design, and may require approval of the conditions of shipment. Type B(M) packages are those Type B package designs which have a maximum normal operating pressure of more than 7 kilograms per square centimeter (100 pounds per square inch) gauge or a relief device which would allow the release of radioactive material to the environment under the hypothetical accident conditions specified in 10 CFR Part 71.

(ff) "Type B(U) package" means a Type B packaging, together with its radioactive contents, that for international shipments, requires unilateral approval only of the package design and of any stowage provisions that may be necessary for heat dissipation.

(gg) "Type A packaging" means a packaging designed to retain the integrity of containment and shielding required by this part under normal conditions of transport as demonstrated by the tests set forth in §§ 173.465 or 173.466, as appropriate.

(hh) "Type B packaging" means a packaging designed to retain the integrity of containment and shielding required by this part when subjected to the normal conditions of transport and hypothetical accident test conditions set forth in 10 CFR Part 71.

(ii) "Uncompressed gas" means, for the purposes of this subpart, gas at a pressure not exceeding the ambient

atmospheric pressure at the time and location the containment system is closed. All other radioactive gases are considered to be compressed.

(jj) "Unilateral approval" means approval by the competent authority of the country of origin only.

(kk) "Unirradiated thorium" means thorium containing not more than 10^{-7} grams uranium-233 per gram of thorium-232.

(ll) "Unirradiated uranium" means uranium containing not more than 10^{-6} grams plutonium per gram of uranium-235 and a fission product activity of not more than 0.25 millicuries of fission products per gram of uranium-235.

§ 173.411 General design requirements.

Except for a package that contains a limited quantity or excepted device under §§ 173.421 through 173.424, each package used for shipment of radioactive materials shall be designed so that—

(a) The package can be easily handled and properly secured in or on a conveyance during transport;

(b) A package with a gross weight exceeding 10 kilograms (22 pounds) and up to 50 kilograms (110 pounds) has a means for manual handling;

(c) A package with a gross weight of 50 kilograms (110 pounds) or more can be safely handled by mechanical means;

(d) Each lifting attachment on the package, when used in the intended manner, with a minimum safety factor of three, does not impose an unsafe stress on the structure of the package. In addition, the lifting attachment shall be so designed that failure under excessive load would not impair the ability of the package to meet all other requirements of this subpart. Each attachment or other feature on the outer surface of the packaging that could be used to lift the package must be removable or otherwise capable of being made inoperable for transport, or shall be designed with strength equivalent to that required for lifting attachments;

(e) The external surface, as far as practicable, may be easily decontaminated;

(f) The outer layer of packaging will avoid, as far as practicable, pockets or crevices where water might collect; and

(g) Each feature that is added to the package at the time of transport, and that is not a part of the package, will not reduce the safety of the package.

§ 173.412 Additional design requirements for Type A packages.

In addition to meeting the general design requirements prescribed in § 173.411, each Type A packaging shall be designed so that:

(a) The smallest overall external dimension of the package is not less than 10 centimeters (4 inches);

(b) The outside of the packaging incorporates a feature, such as a seal, that is not readily breakable, and that, while intact, is evidence that the package has not been opened. In the case of packages shipped in exclusive use closed transport vehicles, the cargo compartment may be sealed instead of the individual packages;

(c) As far as practicable, the external surfaces are free from protrusions and are designed and finished so that they can be easily decontaminated;

(d) Containment and shielding would be maintained during transportation and storage in a temperature range of -40°C (-40°F) to 70°C (158°F) with account being taken of the possibility of brittle fracture;

(e) It is able to withstand the effects of any acceleration, vibration, or vibration resonance that may arise during normal transportation, without any deterioration of the effectiveness of closing devices or of the integrity of the package as a whole and without loosening or unintentional release of nuts, bolts, or other securing devices even after repeated use;

(f) It includes a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by pressure that may arise within the package during normal transport. Special form, as demonstrated in accordance with § 173.469 may be considered as a component of the containment system;

(g) The materials of the packaging and any components or structures are physically and chemically compatible with each other and with the contents, taking into account the behavior of each under irradiation;

(h) For each component of the containment system account is taken, where applicable, of radiolytic decomposition of materials and the generation of gas by chemical reaction and radiolysis;

(i) The containment system will retain its radioactive contents under the reduction of ambient pressure to .25 kilograms per square centimeter (3.5 pounds per square inch);

(j) Each valve through which the radioactive contents could otherwise escape is protected against damage and unauthorized operation and, except for a pressure relief device, has an enclosure to retain any leakage;

(k) Any radiation shield that encloses a component of the packaging specified as part of the containment system will prevent the unintentional escape of that component from the shield;

(l) Failure of any tie down attachment on the packaging under excessive load will not impair the ability of the package to meet other requirements of this subpart;

(m) When subjected to the tests specified in § 173.465 or evaluated against these tests by any of the methods authorized by § 173.461(a), the packaging will prevent—

(1) Loss or dispersal of the radioactive contents; and

(2) Any significant increase in the maximum radiation level recorded or calculated at the external surface for the condition before the test;

(n) Each packaging designed for liquids will—

(1) Meet the conditions prescribed in paragraph (m) of this section when subjected to the tests specified in § 173.466 or evaluated against these tests by any of the methods authorized by § 173.461(a);

(2) For any package with a liquid volume not exceeding 50 cubic centimeters (1.7 fluid ounces), have sufficient suitable absorbent material to absorb twice the volume of the liquid contents. The absorbent material shall be compatible with the package contents and suitably positioned to contact the liquid in the event of leakage; and

(3) For any package with a liquid volume exceeding 50 cubic centimeters (1.7 fluid ounces), either;

(i) Have sufficient absorbent material as prescribed in paragraph (n)(2) of this section; or

(ii) Have a containment system composed of primary inner and secondary outer containment components designed to assure retention of the liquid contents within the secondary outer components in the event that the primary inner components leak; and

(o) Each package designed for compressed or uncompressed gases other than tritium or argon-37 not exceeding 200 curies will be able to prevent loss of contents when the package is subjected to the tests prescribed in § 173.466 or evaluated against these tests by any of the methods authorized by § 173.461(a).

§ 173.413 Requirements for Type B packages.

Each Type B(U) or Type B(M) package must be designed and constructed to meet the applicable requirements in 10 CFR Part 71.

§ 173.415 Authorized Type A packages.

The following packages are authorized for shipment, if they do not

contain quantities exceeding A_1 or A_2 as appropriate:

(a) U.S. Department of Transportation (DOT) Specification 7A (§ 178.350 of this subchapter) Type A general packaging. Each shipper of a Specification 7A package must maintain on file for at least one year after the latest shipment, and shall provide to DOT on request, a complete documentation of tests and an engineering evaluation or comparative data showing that the construction methods, packaging design, and materials of construction comply with that specification. Specification 7A packagings designed in accordance with the requirements of § 178.350 in effect on June 30, 1983, and constructed prior to July 1, 1985, may continue to be used. Packagings either designed or constructed after June 30, 1985, must meet the requirements of § 178.350 applicable at the time of their design or construction.

(b) DOT Specification 55 metal-encased shielded packaging constructed before April 1, 1975. Such packaging constructed after March 31, 1975 is not authorized unless it is requalified under DOT Specification 7A. Each packaging designed for liquids must also meet the requirements of § 173.412 (m) and (n). Use of this packaging as DOT Specification 55 is not authorized after June 30, 1985.

(c) Any Type B(U) or B(M) packaging, pursuant to § 173.416.

(d) Any foreign made packaging that bears the marking "Type A" and complies with the regulations of the country of origin applicable to Type A packages.

§ 173.416 Authorized Type B packages.

Each of the following packages is authorized for shipment of quantities exceeding A_1 or A_2 , as appropriate:

(a) DOT Specification 55 metal-encased shielded packaging constructed before April 1, 1975, for domestic shipments only of special form radioactive materials of 300 curies or less. Such packaging constructed after March 31, 1975 may not be designated as DOT Specification 55. Use of this packaging is not authorized after June 30, 1985 unless approved in accordance with paragraph (b) of this section.

(b) Any Type B(U) or Type B(M) packaging that meets the applicable requirements in the regulations of the U.S. Nuclear Regulatory Commission (10 CFR Part 71) and that has been approved by that Commission may be shipped pursuant to § 173.471.

(c) Any type B(U) or B(M) packaging that meets the applicable requirements of the regulations of the International Atomic Energy Agency (IAEA) in its

"Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)" and for which the foreign competent authority certificate has been revalidated by DOT pursuant to § 173.472. Authorized only for export and import shipments.

(d) DOT Specification 6M (§ 178.104 of this subchapter) metal packaging, only for solid or gaseous radioactive materials that will not undergo pressure generating decomposition at temperatures up to 121°C (250° F) and that do not generate more than 10 watts of radioactive decay heat.

(e) For contents in other than special form; DOT Specification 20 WC (§ 178.194 of this subchapter), wooden protective jacket, when used with a single, snug-fitting inner DOT Specification 2R (§ 178.34 of this subchapter), or a DOT Specification 55 container constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. For liquid contents, the inner packaging must comply with § 173.412 (m) and (n).

(f) For contents in special form only; DOT Specification 20WC (§ 178.194 of this subchapter), wooden protective jacket, with a single snug-fitting inner Type A packaging that has a metal outer wall and conforms to § 178.350 of this subchapter, or an inner DOT Specification 55 packaging constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. Radioactive decay heat may not exceed 100 watts.

(g) For contents in special form only; DOT Specification 21WC (§ 178.195 of this subchapter), wooden protective overpack, with a single inner DOT Specification 2R (§ 178.34 of this subchapter) or an inner DOT Specification 55 container constructed prior to April 1, 1975. Such packagings constructed after March 31, 1975, may not be designated as DOT Specification 55. Contents shall be loaded within the inner packaging in such a manner as to prevent loose movement during transportation. The inner packaging shall be securely positioned and centered within the overpack so that there will be no significant displacement of the inner packaging if subjected to the 9 meter (30 feet) drop test described in 10 CFR Part 71.

§ 173.417 Authorized packaging—Fissile materials.

(a) Except as provided in § 173.453, fissile materials containing not more than A_1 or A_2 as appropriate, shall be

packaged in one of the following packagings:

(1) DOT Specification 6L (§ 178.103 of this subchapter), metal packaging, for materials prescribed in paragraph (b)(1) of this section.

(2) DOT Specification 6M (§ 178.104 of this subchapter), metal packaging, for materials prescribed in paragraph (b)(2) of this section.

(3) Any packaging listed in § 173.415, limited to the following radioactive materials:

(i) 500 grams of uranium-235 in a single shipment as Fissile Class III or not more than 40 grams of uranium-235 per package as Fissile Class II. For Fissile Class II shipments, the transport index assigned to each package shall not be less than 0.4 for each gram of uranium-235 above 15 grams up to the maximum of 40 grams (transport index of 10).

(ii) 320 grams of plutonium-239 as plutonium-beryllium neutron sources in special form. Total radioactivity content may not exceed 20 curies. The transport index to be assigned to each package must be 0.5 of each 20 grams, or fraction thereof, of fissile plutonium.

(4) Any other Type A or Type B packaging for fissile radioactive materials that also meets the applicable standards for fissile materials in the regulations of the U.S. Nuclear Regulatory Commission (10 CFR Part 71), and is used in accordance with § 173.471.

(5) Any other Type A or Type B packaging that also meets the applicable requirements for fissile material packaging in Section VI of the International Atomic Energy Agency "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)", and for which the foreign competent authority certificate has been revalidated by the Associate Director for HMR, in accordance with § 173.472. Authorized only for export and import shipments.

(6) A DOT Specification 6J (§ 178.100 of this subchapter) or 17H (§ 178.118 of this subchapter) 55-gallon steel drum, subject to the following conditions:

(i) The quantity may not exceed 350 grams of uranium-235 in any non-pyrophoric form, enriched to any degree in the uranium-235 isotope.

(ii) Each drum must have a minimum 18 gauge body and bottom head and 16 gauge removable top head with one or more corrugations in the cover near the periphery.

(iii) Closure must conform to § 178.103-5(a) of this subchapter.

(iv) At least four equally spaced 12 millimeter (0.5 inch) diameter vent holes shall be provided on the sides of the drum near the top, each covered with weatherproof tape or equivalent device.

(v) Appropriate primary inner containment of the contents and sufficient packaging material, such as plastic or metal jars or cans shall be provided such that Specification 7A (§ 173.350 of this subchapter) provisions are satisfied by the inner packaging.

(vi) Each inner container shall be capable of venting if subjected to the thermal test described in 10 CFR Part 71.

(vii) Liquid contents shall be packaged in accordance with § 173.412(m) and (n).

(viii) The maximum weight of contents including internal packaging may not exceed 91 kilograms (200 pounds) with fissile material content limited as shown in Table 2:

TABLE 2.—FISSILE MATERIAL CONTENT AND TRANSPORT INDEX FOR SPECIFICATION 6J OR 17H PACKAGES

Maximum U-235 per package (grams)	Minimum transport index per package as Fissile Class II	Maximum packages per transport vehicle as Fissile Class III
350	1.8	72
300	1.0	129
250	0.5	256
200	0.3	500
150	0.1	500
100	0.1	500

TABLE 2.—FISSILE MATERIAL CONTENT AND TRANSPORT INDEX FOR SPECIFICATION 6J OR 17H PACKAGES—Continued

Maximum U-235 per package (grams)	Minimum transport index per package as Fissile Class II	Maximum packages per transport vehicle as Fissile Class III
50	(¹)	(¹)

¹ Fissile Class I.

(7) Any metal cylinder that meets the performance requirements of §§ 173.415 and 178.350 of this subchapter for Specification 7A Type A packaging may be used as a Fissile Class I package for the transport of residual "heels" of enriched solid uranium hexafluoride without a protective overpack in accordance with Table 3:

TABLE 3.—ALLOWABLE CONTENT OF URANIUM HEXAFLUORIDE (UF₆) "HEELS" IN A SPECIFICATION 7A CYLINDER

Maximum cylinder diameter		Cylinder volume		Maximum Uranium-235 enrichment (weight percent)	Maximum "heel" weight per cylinder			
Inches	Centimeters	Cubic Feet	Liters		UF ₆		Uranium-235	
					kg	(lb)	kg	(lb)
5	12.7	0.311	8.8	100.0	0.045	0.1	0.031	0.07
8	20.3	1.359	39	12.5	0.227	0.5	.019	0.04
12	30.5	2.410	68	5.0	0.454	1.0	.015	0.03
30	76	25.64	725	5.0	11.3	25.0	.383	0.84
48	122	108.9 (10 ton)	3084	4.5	22.7	50	.690	1.52
		142.7 (14 ton)	4041					

(8) DOT Specifications 20PF-1, 20PF-2, or 20PF-3 (§ 178.120 of this subchapter) or Specifications 21PF-1 or 21PF-2 (§ 178.121 of this subchapter) phenolic-foam insulated overpack with snug fitting inner metal cylinders, for materials prescribed in paragraph (b)(5) of this section.

(b) Fissile radioactive materials with radioactive content exceeding A₁ or A₂ shall be packaged in one of the following packagings:

(1) DOT Specification 6L (§ 178.103 of this subchapter), metal packaging.

Authorized only for uranium-235, plutonium-239 or plutonium-241, as metal, oxide, or compounds that do not decompose at temperatures up to 149°C (300°F). Radioactive decay heat output may not exceed 5 watts. Radioactive materials in normal form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT Specification 2R (§ 178.34 of this subchapter) containment vessel. Packages are authorized as Fissile Class II and III with materials limited in accordance with Table 4:

TABLE 4.—AUTHORIZED CONTENTS IN KILOGRAMS (KG) AND CONDITIONS FOR SPECIFICATION 6L PACKAGES

Uranium-235		Plutonium ¹			
H/X < 3 ²	3 < H/X < 10	H/X < 10	10 < H/X < 20	Fissile class II transport index	Fissile class III maximum number of packages per transport vehicle
14	3.6	2.5	2.4	1.3 1.8	80 50

¹ Plutonium solutions are not authorized.

² H/X is the ratio of hydrogen to fissile atoms in the inner containment with all sources of hydrogen in the containment considered.

³ Volume not to exceed 3.6 liters.

(2) DOT Specification 6M (§ 178.104 of this subchapter), metal packaging. Authorized only for solid radioactive materials that will not decompose at temperatures up to 121°C (250°F). Radioactive decay heat output may not

exceed 10 watts. Radioactive materials in other than special form shall be packaged in one or more tightly sealed metal cans or polyethylene bottles within a DOT Specification 2R (§ 178.34

of this subchapter) containment vessel. For fissile materials:

(i) Fissile Class I packages are limited to the following amounts of fissile radioactive materials: 1.6 kilograms of uranium-235; 0.9 kilograms of plutonium (except that due to the 10-watt thermal decay heat limitation, the limit for plutonium-238 is 0.02 kilograms); and 0.5 kilograms of uranium-233. The maximum ratio of hydrogen to fissile material must not exceed three, including all of the sources of hydrogen within the DOT Specification 2R containment vessel.

(ii) Maximum quantities of fissile material for Fissile Class II and Fissile Class III, and other restrictions are given in Table 5. For a Fissile Class II package, the minimum transport index to be assigned is shown in Table 5 and for a Fissile Class III shipment, the allowable number of similar packages per transport vehicle is shown. Each Fissile Class III shipment is also subject to the requirements in § 173.457. Where a maximum ratio of hydrogen to fissile material is specified in Table 5, only the hydrogen interspersed with the fissile material need be considered. For a uranium-233 shipment, the maximum inside diameter of the inner containment vessel must not exceed 12.1 centimeters (4.75 inches). Where necessary, a tight fitting steel insert shall be used to

reduce a larger diameter inner containment vessel specified in

§ 178.104-3(b) of this subchapter to the 12 centimeter (4.75 inch) limit.

TABLE 5.—AUTHORIZED CONTENTS FOR SPECIFICATION 6M PACKAGES¹

Uranium-233 ³			Uranium-235 ^{4,5}			Plutonium ^{2,3,4}			Fissile class II transport index	Fissile class III maximum number of packages per transport vehicle
Metal or alloy	Compounds		Metal or alloy	Compounds		Metal or alloy	Compounds			
	H/X=0	H/X<3		H/X=0	H/X<3		H/X=0	H/X<3		
* H/X=0	H/X=0	H/X<3	H/X=0	H/X=0	H/X<3	H/X=0	H/X=0	H/X<3		
3.6	4.4	2.9	7.2	7.6	5.3	3.1	4.1	3.4	0.1	1,250
4.2	5.2	3.5	8.7	9.6	6.4	3.4	4.5	4.1	0.2	625
5.2	6.8	4.5	11.2	13.9	8.3	4.2		4.5	0.5	250
			13.5	16.0	10.1	4.5			1.0	125
				26.0	16.1				5.0	25
				32.0	19.5				10.0	12

¹ Quantity in kilograms.

² Minimum percentage of plutonium-240 is 5 weight percent.

³ 4.5 kilogram limitation of plutonium due to 10 watt decay heat limitation.

⁴ For a mixture of uranium-235 and plutonium an equal amount of uranium-235 may be substituted for any portion of plutonium authorized.

⁵ Maximum inside diameter of Specification 2R containment vessel not to exceed 12 centimeter (4.75 inch) (see par. (b)(2)(iv) of this section).

⁶ Granulated or powdered metal with any particle less than 8 millimeter (0.25 inch) in the smallest dimension is not authorized.

⁷ Maximum permitted uranium-235 enrichment is 93.5 percent.

⁸ H/X is the ratio of hydrogen to fissile atoms in the inner containment with all sources of hydrogen in the containment considered.

(3) Type B(U) or B(M) packaging that meets the standards for packaging of fissile materials in 10 CFR Part 71, and is approved by the U.S. Nuclear Regulatory Commission in accordance with § 173.471.

(4) Type B(U) or B(M) packaging that meets the applicable requirements for fissile radioactive materials in Section VI of the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)" and for which the foreign competent authority certificate has been revalidated by the Associate Director for HMR in accordance with § 173.472. Authorized only for import and export shipments.

(5) DOT Specification 20PF-1, 20PF-2, or 20PF-3 (§ 178.120 of this subchapter) or Specification 21PF-1 or 21PF-2 (§ 178.121 of this subchapter) phenolic-foam insulated protective overpacks, with snugfitting inner metal cylinders meeting all of the applicable requirements of §§ 173.24, 173.411, and 173.412. Handling procedures and packaging criteria shall be in accordance with U.S. Department of Energy Report No. ORO-651 or ANSI Standard N-14.1-1971. Quantities of uranium; hexafluoride are authorized as shown in Table 6, with each package to be shipped as Fissile Class II, and assigned a minimum transport index as also shown:

TABLE 6.—AUTHORIZED QUANTITIES OF URANIUM HEXAFLUORIDE (UF₆) AS FISSILE CLASS II

Protective overpack specification number	Maximum inner cylinder diameter		Maximum weight of UF ₆ contents		Maximum U-235 enrichment (weight percent)	Fissile Class II transport index
	Centimeter	Inch	Kilograms	Pounds		
20PF-1	12.7	5	25	55	100.0	0.1
20PF-2	20.3	8	116	255	12.5	4.0
20PF-3	30.5	12	209	460	5.0	1.1
21PF-1	76	30	2,247	4,950	5.0	5.0
	76	30	2,279	5,020	5.0	5.0
21PF-2	76	30	2,247	4,950	5.0	5.0
	76	30	2,279	5,020	5.0	5.0

¹ For 76 centimeter cylinders, the maximum permitted H/U atomic ratio is 0.088.

² Model 30A inner cylinder (Reference: ORO-651).

³ Model 30B inner cylinder (Reference: ORO-651).

§ 173.416 Authorized packaging-pyrophoric radioactive materials.

(a) Pyrophoric radioactive materials, as referenced in § 172.101 of this subchapter, in quantities not exceeding A₂ per package shall be packaged in Type A packagings which are

constructed of materials which will not react nor be decomposed by the contents. Contents must be:

- (1) In solid form and must not be fissile unless excepted by § 173.453;
- (2) Contained in sealed and corrosion resistant receptacles with positive

closures (friction or slip-fit covers or stoppers are not authorized);

(3) Free of water and any contaminants which would increase the reactivity of the material; and

(4) Made inert to prevent self-ignition during transport by either:

(i) Mixing with large volumes of inerting materials such as graphite or dry sand, or other suitable inerting material, or blended into a matrix of hardened concrete; or

(ii) By filling the innermost receptacle with an appropriate inert gas.

(b) In addition to the applicable requirements of § 173.24 each package must be capable of passing the test conditions of § 173.465 without leakage of contents.

§ 173.419 Authorized packaging-oxidizing radioactive materials.

Certain oxidizing radioactive materials, as referenced in § 172.101 of this subchapter, and which are not fissile materials and not in quantities exceeding A₂, shall be packed in suitable inside packagings of glass, metal or compatible plastic and suitably cushioned with a material which will not react with the contents. Inner packaging and cushioning shall be enclosed within an outside packaging of wood, metal, or plastic. The package shall be capable of meeting the applicable test requirements of § 173.465 without leakage of contents. For shipment by air, the maximum quantity in any package may not exceed 11.3 kilograms (25 pounds).

§ 173.421 Limited quantities of radioactive materials.

Radioactive materials whose activity per package does not exceed the limits specified in § 173.423 are excepted from the specification packaging, marking, and labeling requirements of this subchapter and requirements of this subpart if—

(a) The materials are packaged in strong, tight packages that will not leak any of the radioactive materials during conditions normally incident to transportation;

(b) The radiation level at any point on the external surface of the package does not exceed 0.5 millirem per hour;

(c) The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in § 173.443(a);

(d) The outside of the inner packaging or if there is no inner packaging, the outside of the packaging itself bears the marking "Radioactive"; and

(e) Except as provided in § 173.424, the package does not contain more than 15 grams of uranium-235.

§ 173.422 Exceptions for instruments and articles.

Instruments and manufactured articles (including clocks, electronic tubes or apparatus) or similar devices having radioactive materials in gaseous or non-dispersible solid form as a component part are excepted from the specification packaging, marking and labeling requirements of this subchapter and requirements of this subpart, if—

(a) The activity of the instrument or device does not exceed the relevant limit listed in the table in § 173.423;

(b) The total activity per package does not exceed the relevant limit listed in Table 7 in § 173.423;

(c) The radiation level at 10 centimeters (4 inches) from any point on the external surface of any unpackaged instrument or device does not exceed 10 millirem per hour;

(d) The radiation level at any point on the external surface of a package bearing the device or instrument does not exceed 0.5 millirem per hour, or, for exclusive use domestic shipments, 2 millirem per hour;

(e) The nonfixed (removable) radioactive surface contamination on the external surface of the package does not exceed the limits specified in § 173.443(a);

(f) Except as provided in § 173.424, the package does not contain more than 15 grams of uranium-235; and

(g) At least one external dimension of the package is not less than 10 centimeters (4 inches).

§ 173.423 Table of activity limits—excepted quantities and devices.

The limits applicable to instruments, devices, and limited quantities subject to exceptions under §§ 173.421 and 173.422 are shown in Table 7:

TABLE 7.—ACTIVITY LIMITS FOR LIMITED QUANTITIES, INSTRUMENTS, AND DEVICES

Nature of contents	Instruments and devices		Materials package limits
	Instrument and article limits ¹	Package limits	
Solids:			
Special form.....	$10^{-6}A_1$	A_1	$10^{-6}A_1$
Other forms.....	$10^{-6}A_2$	A_2	$10^{-6}A_2$
Liquids:			
Tritiated water:			
<0.1 Ci/liter.....			1000 Curies.
0.1 Ci to 1.0 Ci/l.....			100 Curies.
>1.0 Ci/liter.....			1 Curie.
Other liquids.....	$10^{-6}A_1$	$10^{-6}A_1$	$10^{-6}A_2$
Gases:			
Tritium ²	20 Curies.....	200 Curies.....	20 Curies.
Special form.....	$10^{-6}A_1$	$10^{-6}A_1$	$10^{-6}A_1$
Other forms.....	$10^{-6}A_2$	$10^{-6}A_2$	$10^{-6}A_1$

¹For mixture of radionuclides see § 173.433(b).

²These values also apply to tritium in activated luminous paint and tritium adsorbed on solid carriers.

§ 173.424 Excepted articles containing natural uranium or thorium.

Manufactured articles in which the sole radioactive material content is natural or depleted uranium or natural thorium are excepted from the specification packaging, marking and labeling requirements of this subchapter and requirements of this subpart if—

(a) The outer surface of the uranium or thorium is enclosed in an inactive sheath made of metal or other protective material; and

(b) The conditions specified in § 173.421 (b), (c), and (d) are met.

§ 173.425 Transport requirements for low specific activity (LSA) radioactive materials.

In addition to other applicable requirements specified in this subchapter, low specific activity (LSA) materials shall be transported in accordance with paragraph (a) of this section, or if transported as exclusive-

use may be transported in accordance with paragraph (b) or (c) of this section.

(a) DOT Specification 7A (§ 178.350 of this subchapter) Type A package. The requirements of § 173.412 (a), (b), (d), and (n) do not apply.

(b) Packaged shipments of LSA material consigned as exclusive use shall either be in accordance with paragraph (a) of this section or shall comply with the following in which case they are excepted from specification packaging, marking and labeling:

(1) Materials must be packaged in strong, tight packages so that there will be no leakage of radioactive material under conditions normally incident to transportation.

(2) Packages must not have any significant removable surface contamination (see § 173.443).

(3) External radiation levels must comply with § 173.441.

(4) Shipments must be loaded by consignor and unloaded by consignee from the transport vehicle in which originally loaded.

(5) There must be no loose radioactive material in the car or vehicle.

(6) Shipment must be braced so as to prevent shifting of lading under conditions normally incident to transportation.

(7) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded with the placards prescribed in accordance with Subpart F of Part 172 of this subchapter, as appropriate.

(8) The exterior of each outside package must be stenciled or otherwise marked "Radioactive—LSA".

(9) Specific instructions for maintenance of exclusive use shipment controls must be provided by the shipper to the carrier. Such instructions must be included with the shipping paper information.

(10) Transportation by aircraft is prohibited.

(c) Unpackaged (bulk) shipments of LSA materials shall be transported only in exclusive use closed transport vehicles and shall comply with the following:

(1) Authorized materials are limited to the following:

(i) Uranium or thorium ores and physical or chemical concentrates of those ores.

(ii) Uranium metal or natural thorium metal, or alloys of these materials.

(iii) Materials of low radioactive concentration, if the average estimated radioactivity concentration does not exceed 0.001 millicurie per gram and the contribution from materials with an A_2 value (see § 173.435) of less than 0.05 curie does not exceed one percent of the total radioactivity.

(iv) Objects of nonradioactive material externally contaminated with radioactive material, if the radioactive material is not readily dispersible and the surface contamination, when averaged over one square meter, does not exceed 0.0001 millicurie per square centimeter of radionuclides for which the A_2 value is less than 0.05 or 0.0001 millicurie per square centimeter of other radionuclides. Such objects must be suitably wrapped or enclosed.

(2) Bulk liquids must be transported in the following: (i) Specification 103CW, 111A60W7 (§§ 179.200, 179.201, 179.202 of this subchapter) tank cars. Bottom openings in tanks prohibited.

(ii) Specification MC 310, MC 311, MC 312, or MC 331 (§§ 178.343 or 178.337 of this subchapter) cargo tanks. Authorized only where the radioactivity

concentration does not exceed 10 percent of the specified low specific activity levels (see § 173.403(n)). The requirements of § 173.412(n) do not apply to these cargo tanks. Bottom fittings and valves are not authorized. Trailer-on-flat-car service is not authorized.

(3) External radiation levels must comply with § 173.441(b).

(4) Shipments must be loaded by the consignor, and unloaded by the consignee from the transport vehicle in which originally loaded.

(5) Except for shipments of unconcentrated uranium or thorium ores, the transport vehicle must be placarded with the placards prescribed in Subpart F of Part 172 of this subchapter, as appropriate.

(6) There must be no leakage of radioactive materials from the vehicle.

(7) Specific instructions for maintenance of exclusive use shipment controls must be provided by the shipper to the carrier. Such instructions must be included with the shipping paper information.

(8) Transportation by aircraft is prohibited.

§ 173.427 Empty radioactive materials packaging.

Any packaging which previously contained radioactive materials and has been emptied of contents as far as practical, is excepted from marking and labeling requirements of this subchapter and from requirements of this subpart, provided that:

(a) It complies with the requirements of § 173.421(b), (c) and (e);

(b) The packaging is in unimpaired condition and is securely closed so that there will be no leakage of radioactive material under conditions normally incident to transportation;

(c) Internal contamination does not exceed 1000 times the limits specified in § 173.443, Table 10; and

(d) Any labels previously applied in conformance with Subpart E of Part 172 of this subchapter are removed, obliterated or covered and the "Empty" label prescribed in § 172.450 is affixed to the packaging.

§ 173.431 Activity for Type A and Type B packages.

(a) A Type A package shall not contain radioactive contents with an activity greater than the following, as listed in § 173.435, or for other materials as determined under § 173.433:

(1) For special form radioactive materials, A_1 ; or

(2) For all other radioactive materials, A_2 .

(b) The limits on activity contained in a Type B(U) and Type B(M) package are those prescribed in § 173.416 or in the applicable approval recertification under §§ 173.471 and 173.472.

§ 173.433 Requirements for determination of A_1 and A_2 values for radionuclides.

(a) *Single radionuclides.*

(1) For single radionuclides of known identity, the values of A_1 and A_2 are those given in the table in § 173.435. The values of A_1 and A_2 are also applicable for radionuclides contained in (α, n) or (γ, n) neutron sources.

(2) For any single radionuclide of known identity, which is not listed in § 173.435, the values of A_1 and A_2 shall be determined in accordance with the following:

(i) If the radionuclide emits only one type of radiation, A_1 is determined in accordance with paragraphs (A), (B), (C), and (D) of this subparagraph. For radionuclides emitting different kinds of radiation, A_1 is the most restrictive value of those determined for each kind of radiation. However, in both cases, A_1 is restricted to a maximum of 1000 curies. If a parent nuclide decays into a shorter lived daughter, of a half-life not greater than 10 days, A_1 is calculated for both the parent and the daughter, and the more limiting of the two values is assigned to the parent nuclide.

(A) For gamma emitters, A_1 is determined by the expression: $A_1 = 9 \Gamma$ curie

where Γ is the gamma-ray constant, corresponding to the dose in roentgens per hour at 1 meter per curie; the number 9 results from the choice of 1 rem per hour at a distance of 3 meters as the reference dose-equivalent rate.

(B) For x-ray emitters, A_1 is determined by the atomic number (Z) of the nuclide:

$Z < 55$ $A_1 = 1000$ curies
for $Z > 55$ $A_1 = 200$ curies

(C) For beta emitters, A_1 is determined by the maximum beta energy (E_{max}) according to Table 8:

TABLE 8.— A_1 for Beta Emitters

E_{max} (MeV)	A_1 (curies)
<0.5	1000
0.5–<1.0	300
1.0–<1.5	100
1.5–<2.0	30
>2.0	10

(D) For alpha emitters, A_1 is determined by the expression:

$A_1 = 1000 A_2$

where A_2 is the value listed in Table 9:

TABLE 9.— A_2 for Alpha Emitters

Atomic number	A_2		
	Half-life less than 1,000 days	Half-life 1,000 days to 10^4 years	Half-life greater than 10^4 years
1 to 81	3 curies	50 millicuries	3 curies
82 and above.	2 millicuries	2 millicuries	3 curies

(ii) For assignment of A_2 values, A_2 is the more restrictive of the following values:

(A) The corresponding A_1 .

(B) The value A_2 obtained from Table 9.

(3) For any single radionuclide whose identity is unknown, the value of A_1 is 2 curies and the value of A_2 is 0.002 curies. However, if the atomic number of the radionuclide is less than 82, the value of A_1 is 10 curies and the value of A_2 is 0.4 curies.

(b) *Mixture of radionuclides, including radioactive decay chains.*

(1) For mixed fission products, where a detailed analysis of the mixture is not carried out, the following activity limits apply:

(i) $A_1 = 10$ curies.

(ii) $A_2 = 0.4$ curies.

(2) A single radioactive decay chain is considered to be a single radionuclide when the radionuclides are present in their naturally occurring portions and no daughter nuclide has a half-life either longer than 10 days or longer than that of the parent nuclide. The activity to be taken into account and the A_1 or A_2 value to be applied are those corresponding to the parent nuclide of that chain. When calculating A_1 or A_2 values, radiation emitted by daughters must be taken into account. However, in the case of radioactive decay chains in which any daughter nuclide has a half-life either longer than 10 days or greater than that of the parent nuclide, the parent and daughter nuclides are considered to be mixtures of different nuclides.

(3) In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide is known, the permissible activity of each radionuclide R_1, R_2, \dots, R_n must be such that $F_1 + F_2 + \dots + F_n$ is not greater than unity, when—

$$F_1 = \frac{\text{Total activity of } R_1}{A_1(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_1(R_2)}$$

$$F_n = \frac{\text{Total activity of } R_n}{A_1(R_n)}$$

Where A_1 ($R_1, R_2 \dots R_n$) is the value of A_1 or A_2 as appropriate for the nuclide $R_1, R_2 \dots R_n$.

(4) When the identity of each radionuclide is known but the individual activities of some of the radionuclides are not known, the formula given in subparagraph (3) of this paragraph must be applied to establish the values of A_1 or A_2 as appropriate. All the radionuclides whose individual activities are not known (but whose total activity is known) must be classed in a single group and the most restrictive value of A_1 or A_2 applicable to any one of them shall be used as the value of A_1

and A_2 in the denominator of the fraction.

(5) Were the identity of each radionuclide is known but the individual activity of the radionuclides is not known, the most restrictive value of A_1 or A_2 applicable to any one of the radionuclides present is the applicable value.

(6) When the identity of the radionuclides is not known, the value of A_1 is 2 curies and the value of A_2 is 0.002 curies. However, if alpha emitters are known to be absent, the value of A_2 is 0.4 curies.

§ 173.434 Activity-mass relationships for uranium and natural thorium.¹

Radioactive material	Curies per gram	Grams per curie
Uranium—(Wt% ²³⁵ U present):		
0.45.....	5.0×10^{-7}	2.0×10^6
0.72 (natural).....	7.06×10^{-7}	1.42×10^6
1.0.....	7.6×10^{-7}	1.3×10^6
1.5.....	1.0×10^{-6}	1.0×10^6
5.0.....	2.7×10^{-6}	3.7×10^5
10.0.....	4.8×10^{-6}	2.1×10^5
20.0.....	1.0×10^{-5}	1.0×10^5
35.0.....	2.0×10^{-5}	5.0×10^4
50.0.....	2.5×10^{-5}	4.0×10^4
90.0.....	5.8×10^{-5}	1.7×10^4
93.0.....	7.3×10^{-5}	1.4×10^4
95.0.....	9.1×10^{-5}	1.1×10^4
Natural thorium.....	2.2×10^{-7}	4.6×10^6

¹ The figures for uranium include representative values for the activity of uranium-234 which is concentrated during the enrichment process. The activity for thorium includes the equilibrium concentration of thorium-232.

§ 173.435 Table of A_1 and A_2 values for radionuclides.

Symbol of radionuclide	Element and atomic number	A_1 (Ci)	A_2 (Ci)	Specific activity (Ci/g)
227Ac.....	Actinium (89).....	1000	0.003	7.2×10^4
228Ac.....	Actinium (89).....	10	4	2.2×10^5
105Ag.....	Silver (47).....	40	40	3.1×10^5
110mAg.....	Silver (47).....	7	7	4.7×10^5
111Ag.....	Silver (47).....	100	20	1.6×10^5
241Am.....	Americium (95) ¹	8	0.008	3.2
243Am.....	Americium (95) ¹	8	0.008	1.9×10^{-1}
37Ar (compressed or uncompressed).....	Argon (18).....	1000	1000	1.0×10^5
41Ar (uncompressed).....	Argon (18).....	20	20	4.3×10^5
41Ar (compressed).....	Argon (18).....	1	1	4.3×10^5
75As.....	Arsenic (33).....	1000	400	2.4×10^5
74As.....	Arsenic (33).....	20	20	1.0×10^5
76As.....	Arsenic (33).....	10	10	1.6×10^5
77As.....	Arsenic (33).....	300	20	1.1×10^5
211At.....	Astatine (85).....	200	7	2.1×10^5
193Au.....	Gold (79).....	200	200	9.3×10^4
196Au.....	Gold (79).....	30	30	1.2×10^5
198Au.....	Gold (79).....	40	20	2.5×10^5
199Au.....	Gold (79).....	200	25	2.1×10^5
131Ba.....	Barium (56).....	40	40	8.7×10^4
133Ba.....	Barium (56).....	40	10	4.0×10^5
140Ba.....	Barium (56).....	20	20	7.3×10^4
7Be.....	Beryllium (4).....	300	300	3.5×10^5
206Bi.....	Bismuth (83).....	5	5	9.9×10^4
207Bi.....	Bismuth (83).....	10	10	2.2×10^5
210Bi (stable).....	Bismuth (83).....	100	4	1.2×10^5
212Bi.....	Bismuth (83).....	6	6	1.5×10^7
249Bk.....	Berkelium (97).....	1000	1	1.8×10^5
77Br.....	Bromine (35).....	70	25	7.1×10^5
82Br.....	Bromine (35).....	6	6	1.1×10^6
11C.....	Carbon (6).....	20	20	8.4×10^4
14C.....	Carbon (6).....	1000	60	4.6
45Ca.....	Calcium (20).....	1000	25	1.9×10^4
47Ca.....	Calcium (20).....	20	20	5.9×10^5
109Cd.....	Cadmium (48).....	1000	70	2.6×10^5
115mCd.....	Cadmium (48).....	30	30	2.6×10^4
115Cd.....	Cadmium (48).....	80	20	5.1×10^5
139Ce.....	Cerium (58).....	100	100	6.5×10^5
141Ce.....	Cerium (58).....	300	25	2.8×10^4
143Ce.....	Cerium (58).....	60	20	6.6×10^5
144Ce.....	Cerium (58).....	10	7	3.2×10^5
249Cf.....	Californium (98).....	2	0.002	3.1
250Cf.....	Californium (98).....	7	0.007	1.3×10^5
252Cf.....	Californium (98).....	2	0.009	6.5×10^5
36Cl.....	Chlorine (17).....	300	10	3.2×10^5
38Cl.....	Chlorine (17).....	10	10	1.3×10^5
242Cm.....	Curium (96).....	200	0.2	3.3×10^5
243Cm.....	Curium (96).....	9	0.009	4.2×10^5
244Cm.....	Curium (96).....	10	0.01	8.2×10^5
245Cm.....	Curium (96).....	6	0.006	1.0×10^{-1}
249Cm.....	Curium (96).....	6	0.006	3.6×10^{-1}
56Co.....	Cobalt (27).....	5	5	3.0×10^4
57Co.....	Cobalt (27).....	90	90	8.5×10^5
58mCo.....	Cobalt (27).....	1000	1000	5.9×10^4
58Co.....	Cobalt (27).....	20	20	3.1×10^4
60Co.....	Cobalt (27).....	7	7	1.1×10^5
51Cr.....	Chromium (24).....	600	600	9.2×10^4
129Cs.....	Cesium (55).....	40	40	7.6×10^5
131Cs.....	Cesium (55).....	1000	1000	1.0×10^5
134mCs.....	Cesium (55).....	1000	10	7.4×10^5
134Cs.....	Cesium (55).....	10	10	1.2×10^5

Symbol of radionuclide	Element and atomic number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
135 _{Cs}		1000	25	8.8×10 ⁻⁴
136 _{Cs}		7	7	7.4×10 ⁻⁴
137 _{Cs}		30	10	9.8×10 ⁻⁴
64 _{Cu}	Copper (29)	80	25	3.8×10 ⁻⁴
67 _{Cu}		200	25	7.9×10 ⁻⁴
165 _{Dy}	Dysprosium (66)	100	20	8.2×10 ⁻⁴
166 _{Dy}		1000	200	2.3×10 ⁻⁴
169 _{Er}	Erbium (68)	1000	25	8.2×10 ⁻⁴
171 _{Er}		50	20	2.4×10 ⁻⁴
152 _{Eu}	Europium (63)	30	30	2.2×10 ⁻⁴
152 _{Gd}		20	10	1.9×10 ⁻⁴
154 _{Gd}		10	5	1.5×10 ⁻⁴
155 _{Gd}		400	60	1.4×10 ⁻⁴
18 _F	Fluorine	20	20	9.3×10 ⁻⁵
52 _{Fe}	Iron (26)	5	5	7.3×10 ⁻⁵
55 _{Fe}		1000	1000	2.2×10 ⁻⁵
56 _{Fe}		10	10	4.9×10 ⁻⁵
67 _{Ga}	Gallium (31)	100	100	6.0×10 ⁻⁵
68 _{Ga}		20	20	4.0×10 ⁻⁵
72 _{Gd}		7	7	3.1×10 ⁻⁵
153 _{Gd}	Gadolinium (64)	200	200	3.6×10 ⁻⁵
159 _{Gd}		300	20	1.1×10 ⁻⁵
68 _{Ge}	Germanium (32)	20	10	7.0×10 ⁻⁵
71 _{Ge}		1000	1000	1.6×10 ⁻⁵
3 _H	Hydrogen (1) See T-Tritium		25	1.6×10 ⁻⁴
181 _{Hf}	Hafnium (72)	30	200	6.8×10 ⁻⁵
197 _{Hg}	Mercury (80)	200	200	2.5×10 ⁻⁵
197 _{Hg}		80	25	1.4×10 ⁻⁵
203 _{Hg}		30	30	6.9×10 ⁻⁵
166 _{Ho}	Holmium (67)	50	50	1.9×10 ⁻⁵
123 _I	Iodine (53)	1000	70	1.7×10 ⁻⁵
125 _I		40	10	7.8×10 ⁻⁵
126 _I		1000	2	1.6×10 ⁻⁵
129 _I		40	10	1.2×10 ⁻⁵
131 _I		7	7	1.1×10 ⁻⁵
132 _I		30	10	1.1×10 ⁻⁵
133 _I		8	8	2.7×10 ⁻⁵
134 _I		10	10	3.5×10 ⁻⁵
135 _I		30	25	4.2×10 ⁻⁵
111 _{In}	Indium (49)	60	60	1.6×10 ⁻⁵
113 _{In}		30	20	2.3×10 ⁻⁵
114 _{In}		100	20	6.1×10 ⁻⁵
115 _{In}		10	10	6.2×10 ⁻⁵
190 _{Ir}	Iridium (77)	20	10	9.1×10 ⁻⁵
192 _{Ir}		10	10	8.5×10 ⁻⁵
194 _{Ir}		10	10	6.0×10 ⁻⁵
42 _K	Potassium (19)	20	10	3.3×10 ⁻⁵
85 _K		100	100	8.4×10 ⁻⁵
85 _K (uncompressed)	Krypton (36)	3	3	8.4×10 ⁻⁵
85 _K (uncompressed)		1000	1000	4.0×10 ⁻⁵
85 _K (uncompressed)		5	5	4.0×10 ⁻⁵
85 _K (compressed)		20	20	2.8×10 ⁻⁵
87 _K (uncompressed)		0.6	0.6	2.8×10 ⁻⁵
87 _K (uncompressed)		30	30	5.6×10 ⁻⁵
140 _{La}	Lanthanum (57)			
138 _{La}	Low specific activity material—see § 173.403			
177 _{Lu}	Lutetium (71)	300	25	1.1×10 ⁻⁵
177 _{Lu}	Mixed fission products	10	0.4	
28 _{Mg}	Magnesium (12)	5	5	5.2×10 ⁻⁵
52 _{Mn}	Manganese (25)	5	5	4.4×10 ⁻⁵
54 _{Mn}		20	20	8.3×10 ⁻⁵
56 _{Mn}		5	5	2.2×10 ⁻⁵
99 _{Mo}	Molybdenum (42)	100	20	4.7×10 ⁻⁵
13 _N	Nitrogen (7)	20	10	1.5×10 ⁻⁵
22 _{Na}	Sodium (11)	6	8	6.3×10 ⁻⁵
24 _{Na}		5	5	8.7×10 ⁻⁵
93 _{Nb}	Niobium (41)	1000	200	1.1×10 ⁻⁵
95 _{Nb}		20	20	3.9×10 ⁻⁵
97 _{Nb}		20	20	2.6×10 ⁻⁵
147 _{Nd}	Neodymium (60)	100	20	8.0×10 ⁻⁵
149 _{Nd}		30	20	1.1×10 ⁻⁵
59 _{Ni}	Nickel (28)	1000	900	8.1×10 ⁻⁵
63 _{Ni}		1000	100	4.6×10 ⁻⁵
65 _{Ni}		10	10	1.9×10 ⁻⁵
237 _{Np}	Neptunium (93)	5	0.005	6.9×10 ⁻⁵
239 _{Np}		200	25	2.3×10 ⁻⁵
185 _{Os}	Osmium (76)	20	20	7.3×10 ⁻⁵
191 _{Os}		600	200	4.6×10 ⁻⁵
191 _{Os}		200	200	1.2×10 ⁻⁵
191 _{Os}		100	20	5.3×10 ⁻⁵
193 _{Os}		30	30	2.9×10 ⁻⁵
32 _P	Phosphorus (15)	20	0.8	3.2×10 ⁻⁵
230 _{Pu}	Protactinium (91)	2	0.002	4.5×10 ⁻⁵
231 _{Pu}		100	100	2.1×10 ⁻⁵
233 _{Pu}		20	20	1.7×10 ⁻⁵
201 _{Pb}	Lead (82)	100	0.2	8.8×10 ⁻⁵
210 _{Pb}		6	5	1.4×10 ⁻⁵
212 _{Pb}		1000	700	7.5×10 ⁻⁵
103 _{Pd}	Palladium (46)	100	20	2.1×10 ⁻⁵
109 _{Pd}		1000	25	9.4×10 ⁻⁵
147 _{Pm}	Promethium (61)	100	20	4.2×10 ⁻⁵
149 _{Pm}		200	0.2	4.5×10 ⁻⁵
210 _{Po}	Polonium (84)	10	10	1.2×10 ⁻⁵
142 _{Pr}	Praseodymium (59)	300	20	6.6×10 ⁻⁵
143 _{Pr}				

Symbol of radionuclide	Element and atomic number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
191 _{Pl}	Platinum (78)	100	100	2.3 × 10 ⁵
193 _{Pl}		200	200	2.0 × 10 ⁵
197 _{Pl}		300	20	1.2 × 10 ⁵
197 _{Pl}		300	20	8.8 × 10 ⁵
238 _{Pl}	Plutonium (94)	3	0.003	1.7 × 10 ⁵
239 _{Pl}		2	0.002	6.2 × 10 ⁵
240 _{Pl}		2	0.002	2.3 × 10 ⁵
241 _{Pl}		1000	0.1	1.1 × 10 ⁵
242 _{Pl}		3	0.003	3.9 × 10 ⁵
223 _{Ra}	Radium (88)	50	0.2	5.0 × 10 ⁴
224 _{Ra}		6	0.5	1.6 × 10 ⁵
226 _{Ra}		10	0.05	1.0
228 _{Ra}		10	0.05	2.3 × 10 ⁵
81 _{Rb}	Rubidium (37)	30	25	6.2 × 10 ⁴
86 _{Rb}		30	30	8.1 × 10 ⁴
87 _{Rb}		Unlimited	Unlimited	6.6 × 10 ⁴
Rb (natural)		Unlimited	Unlimited	1.8 × 10 ⁵
186 _{Rh}	Rhenium (75)	100	20	1.9 × 10 ⁵
187 _{Rh}		Unlimited	Unlimited	3.8 × 10 ⁵
188 _{Rh}		10	1.0	1.0 × 10 ⁵
Rh (natural)		Unlimited	Unlimited	2.4 × 10 ⁵
103 _{Rh}	Rhodium (45)	1000	1000	3.2 × 10 ⁵
105 _{Rh}		200	25	8.2 × 10 ⁵
222 _{Rn}	Radon (86)	10	2	1.5 × 10 ⁵
97 _{Ru}	Ruthenium (44)	80	80	5.5 × 10 ⁵
103 _{Ru}		30	25	3.2 × 10 ⁵
105 _{Ru}		20	20	6.6 × 10 ⁵
106 _{Ru}		10	7	3.4 × 10 ⁵
35 _S	Sulphur (16)	1000	60	4.3 × 10 ⁴
122 _{Sb}	Antimony (51)	30	30	3.9 × 10 ⁴
124 _{Sb}		5	5	1.8 × 10 ⁴
125 _{Sb}		40	25	1.4 × 10 ⁵
46 _{Sc}	Scandium (21)	8	8	3.4 × 10 ⁴
47 _{Sc}		200	20	8.2 × 10 ⁴
48 _{Sc}		5	5	1.5 × 10 ⁵
75 _{Se}	Selenium (34)	40	40	1.4 × 10 ⁴
31 _{Si}	Silicon (14)	100	20	3.9 × 10 ⁴
147 _{Sm}	Samarium (62)	Unlimited	Unlimited	2.0 × 10 ⁵
151 _{Sm}		1000	90	2.6 × 10 ⁴
153 _{Sm}		300	20	4.4 × 10 ⁴
113 _{Sn}	Tin (50)	60	60	1.0 × 10 ⁴
119 _{Sn}		100	100	4.4 × 10 ⁴
125 _{Sn}		10	10	1.1 × 10 ⁵
85 _{Sr}	Strontium (38)	80	80	3.2 × 10 ⁴
85 _{Sr}		30	30	2.4 × 10 ⁴
87 _{Sr}		50	50	1.2 × 10 ⁵
89 _{Sr}		100	10	2.9 × 10 ⁴
90 _{Sr}		10	0.4	1.5 × 10 ⁵
91 _{Sr}		10	10	3.6 × 10 ⁴
92 _{Sr}		10	10	1.3 × 10 ⁵
T (uncompressed)	Tritium (1)	1000	1000	9.7 × 10 ³
T (compressed)		1000	1000	9.7 × 10 ³
T (activated luminous paint)		1000	1000	9.7 × 10 ³
T (adsorbed on solid carrier)		1000	1000	9.7 × 10 ³
T (tritiated water)		1000	1000	9.7 × 10 ³
T (other forms)		1000	1000	9.7 × 10 ³
182 _{Ta}	Tantalum (73)	20	20	9.7 × 10 ³
160 _{Tb}	Terbium (65)	20	20	6.2 × 10 ³
96 _{Tm}	Technetium (43)	20	10	1.1 × 10 ⁴
96 _{Tm}		1000	1000	3.8 × 10 ⁴
97 _{Tm}		6	6	3.2 × 10 ⁵
97 _{Tm}		1000	200	1.5 × 10 ⁵
99 _{Tm}		1000	400	1.4 × 10 ⁵
99 _{Tm}		100	100	5.2 × 10 ⁵
125 _{Te}	Tellurium (52)	1000	25	1.7 × 10 ⁵
127 _{Te}		1000	100	1.8 × 10 ⁵
127 _{Te}		300	20	4.0 × 10 ⁴
129 _{Te}		300	20	2.6 × 10 ⁴
129 _{Te}		30	10	2.5 × 10 ⁴
131 _{Te}		100	20	2.0 × 10 ⁴
132 _{Te}		10	10	8.0 × 10 ⁴
227 _{Th}	Thorium (90)	7	7	3.1 × 10 ⁵
228 _{Th}		200	0.2	3.2 × 10 ⁵
230 _{Th}		6	0.008	8.3 × 10 ⁵
231 _{Th}		3	0.003	1.9 × 10 ⁵
232 _{Th}		1000	25	5.3 × 10 ⁵
234 _{Th}		Unlimited	Unlimited	1.1 × 10 ⁵
Th (natural)		10	10	2.3 × 10 ⁵
Th (irradiated)		Unlimited	Unlimited	2.2 × 10 ⁵
200 _{Tl}	Thallium (81)	20	20	5.8 × 10 ⁴
201 _{Tl}		200	200	2.2 × 10 ⁴
202 _{Tl}		40	40	5.4 × 10 ⁴
204 _{Tl}		300	10	4.3 × 10 ⁴
170 _{Tm}	Thulium (69)	300	40	6.0 × 10 ⁴
171 _{Tm}		1000	10	1.1 × 10 ⁵
230 _U	Uranium (92)	100	0.1	2.7 × 10 ⁴
232 _U		30	0.03	2.1 × 10 ⁴
233 _U		100	0.1	9.5 × 10 ⁴
234 _U		100	0.1	6.2 × 10 ⁴
235 _U		100	0.2	2.1 × 10 ⁵
236 _U		200	0.2	6.3 × 10 ⁵
238 _U		Unlimited	Unlimited	3.3 × 10 ⁵
U (natural)		Unlimited	Unlimited	(see § 173.434).

Symbol of radionuclide	Element and atomic number	A ₁ (Ci)	A ₂ (Ci)	Specific activity (Ci/g)
U (enriched) <20% 20% or greater		Unlimited 100 Unlimited	Unlimited 0.1 Unlimited	(see § 173.434). (see § 173.434). (see § 173.434).
U (depleted)				
U (irradiated)*				
48V.....	Vanadium (23).....	6	6	1.7×10 ⁵
181W.....	Tungsten (74).....	200	100	5.0×10 ⁵
185W.....		1000	25	9.7×10 ⁻³
187W.....		40	20	7.0×10 ⁵
127Xe (uncompressed).....	Xenon (54).....	70	70	2.8×10 ⁵
127Xe (compressed).....		5	5	2.8×10 ⁵
131mXe (compressed).....		10	10	1.0×10 ⁵
131mXe (uncompressed).....		100	100	1.0×10 ⁵
133Xe (uncompressed).....		1000	1000	1.9×10 ⁵
133Xe (compressed).....		5	5	1.9×10 ⁵
135Xe (uncompressed).....		70	70	2.5×10 ⁵
135Xe (compressed).....		2	2	2.5×10 ⁵
135Xe (compressed).....	Yttrium (39).....	20	20	4.5×10 ⁵
87Y.....		10	10	2.5×10 ⁵
90Y.....		30	30	4.1×10 ⁵
91mY.....		30	30	2.5×10 ⁵
91Y.....		10	10	9.5×10 ⁵
92Y.....		10	10	3.2×10 ⁵
93Y.....		80	80	2.3×10 ⁵
169Yb.....	Ytterbium (70).....	400	25	1.8×10 ⁵
175Yb.....		30	30	8.0×10 ⁵
65Zn.....	Zinc (30).....	40	20	3.3×10 ⁵
69Zn.....		300	20	5.3×10 ⁵
69Zn.....		1000	200	3.5×10 ⁻³
93Zr.....	Zirconium (40).....	20	20	2.1×10 ⁵
95Zr.....		20	20	2.0×10 ⁵
97Zr.....		20	20	2.0×10 ⁵

*For shipments solely within the United States the A₁ value is 20 curies for americium and plutonium contained in Am-Be or Pu-Be neutron sources or in nuclear-powered pacemakers.
 †The values of A₁ and A₂ must be calculated in accordance with the procedure specified in § 173.433 of this subchapter, taking into account the activity of the fission products and of the uranium-233 in addition to that of the thorium.
 ‡The values of A₁ and A₂ must be calculated in accordance with the procedure specified in § 173.433 of this subchapter, taking into account the activity of the fission products and plutonium isotopes in addition to that of the uranium.

§ 173.441 Radiation level limitations.

(a) Except as provided in paragraph (b) of this section, each package of radioactive materials offered for transportation shall be designed and prepared for shipment so that under conditions normally incident to transportation the radiation level does not exceed 200 millirem per hour at any point on the external surface of the package, and the transport index does not exceed 10.

(b) Except for shipments by air, a shipment which exceeds the radiation level limits specified in paragraph (a) of this section, may be transported as an exclusive use shipment if the radiation level does not exceed any of the following at any time during transportation:

(1) 200 millirem per hour on the accessible external surface of the package unless the following conditions are met, in which case the limit is 1000 millirem per hour:

- The shipment is made in a closed transport vehicle;
- Provisions are made to secure the package so that its position within the vehicle remains fixed during transportation; and
- There are no loading or unloading operations between the beginning and end of the transportation;

(2) 200 millirem per hour at any point on the outer surface of the vehicle, including the upper and lower surfaces, or, in the case of an open vehicle, at any point on the vertical planes projected

from the outer edges of the vehicle, on the upper surface of the load, and on the lower external surface of the vehicle;

(3) 10 millirem per hour at any point 2 meters (6.6 feet) from the vertical planes represented by the outer lateral surfaces of the vehicle, or, in the case of an open vehicle, at any point 2 meters from the vertical planes projected from the outer edges of the conveyance; and

(4) 2 millirem per hour in any normally occupied position in the car or vehicle, except that this provision does not apply to private motor carriers when the personnel are operating under a radiation protection program and wear radiation exposure monitoring devices.

(c) For shipments made under the provisions of paragraph (b) of this section, the shipper shall provide specific written instructions for maintenance of the exclusive use shipment controls to the carrier. The instructions shall be included with the shipping paper information.

§ 173.442 Thermal limitations.

Each package of radioactive material shall be designed, constructed, and loaded so that—

(a) The heat generated within the package because of the radioactive contents will not, at any time during transportation, affect the integrity of the package under conditions normally incident to transportation; and

(b) The temperature of the accessible external surfaces of the loaded package will not, assuming still air in the shade

at an ambient temperature of 38° C (100° F), exceed either—

- 50° C (122° F) in other than an exclusive use shipment; or
- 82° C (180° F) in an exclusive use shipment.

§ 173.443 Contamination control.

(a) The level of non-fixed (removable) radioactive contamination on the external surfaces of each package offered for shipment shall be kept as low as practicable. The level of non-fixed radioactive contamination may be determined by wiping an area of 300 square centimeters of the surface concerned with an absorbent material, using moderate pressure, and measuring the activity on the wiping material. Sufficient measurements shall be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels. Except as provided in paragraph (b) of this section, the amount of radioactivity measured on any single wiping material when averaged over the surface wiped shall not exceed the limits given in Table 10 at any time during transport. Other methods of assessment of equal or greater efficiency may be used. When other methods are used the detection efficiency of the method used shall be taken into account and in no case shall the non-fixed contamination on the external surfaces of the package exceed ten times the limits listed in Table 10.

TABLE 10.—REMOVABLE EXTERNAL RADIOACTIVE CONTAMINATION LIMITS

Contaminant	Maximum permissible limits	
	uCi/cm ²	dpm/cm ²
Beta-gamma emitting radionuclides; all radionuclides with half-lives less than ten days; natural uranium; natural thorium; uranium-235; uranium-238; thorium-232; thorium-230 and thorium-230 when contained in ores or physical concentrates.....	10 ⁻⁴	22
All other alpha emitting radionuclides.....	10 ⁻⁶	2.2

(b) Except as provided in paragraph (d) of this section, in the case of packages transported as exclusive use shipments by rail or highway only, the removable (non-fixed) radioactive contamination at any time during transport shall not exceed ten times the levels prescribed in paragraph (a) of this section.

(c) Except as provided in paragraph (d) of this section, each transport vehicle used for transporting radioactive materials as an exclusive use shipment which utilizes the provisions of paragraph (b) of this section shall be surveyed with appropriate radiation detection instruments after each use. A vehicle shall not be returned to service until the radiation dose rate at each accessible surface is 0.5 millirem per hour or less, and there is no significant removable (non-fixed) radioactive surface contamination as specified in paragraph (a) of this section.

(d) Paragraph (b) and (c) of this section do not apply to any closed transport vehicle used solely for the transportation of radioactive material packages with contamination levels that do not exceed 10 times the levels prescribed in paragraph (a) of this section if—

(1) A survey of the interior surfaces of the empty vehicle shows that the radiation dose rate at any point does not exceed 10 millirem per hour at the surface or 2 millirem per hour at 1 meter (3.3 feet) from the surface;

(2) Each vehicle is stenciled with the words "For Radioactive Materials Use Only" in letters at least 76 millimeters (3 inches) high in a conspicuous place on both sides of the exterior of the vehicle; and

(3) Each vehicle is kept closed the except for loading or unloading.

§ 173.444 Labeling requirements.

Each package of radioactive materials, unless excepted by §§ 173.421, 173.422, 173.424, 173.425(b), or 173.427 shall be labeled as provided in Subpart E of Part 172 of this subchapter.

§ 173.446 Placarding requirements.

See Subpart F of Part 172 of this subchapter.

§ 173.447 Storage incident to transportation-general requirements.

The following requirements apply to temporary storage during the course of transportation but not to Nuclear Regulatory Commission or Agreement State licensed facilities or U.S. Government owned or contracted facilities.

(a) The number of packages bearing Radioactive Yellow II or Radioactive Yellow III labels stored in any one storage area, such as a transit area, terminal building, store-room, or assembly yard, shall be limited so that the sum of the transport indexes in any individual group of packages does not exceed 50. Groups of these packages must be stored so as to maintain a spacing of at least 6 meters (20 feet) from other groups of packages containing radioactive materials.

(b) Mixing of different kinds of packages, including Fissile Class I packages with Fissile Class II packages, is authorized in accordance with § 173.459 of this subchapter.

§ 173.448 General transportation requirements.

(a) Each shipment of radioactive materials shall be secured in order to prevent shifting during normal transportation conditions.

(b) Except as may be specifically required by the competent authority in the applicable certificate, a package of radioactive materials may be carried among packaged general cargo without special stowage provisions, if:

(1) The heat output in watts does not exceed 0.1 times the minimum package dimension in centimeters; or

(2) The average surface heat flux of the package does not exceed 15 watts per square meter and the immediately surrounding cargo is not in sacks or bags or otherwise in a form that would seriously impede air circulation for heat removal.

(c) Packages bearing labels prescribed in § 172.403 of this subchapter may not be carried in compartments occupied by passengers, except in those compartments exclusively reserved for couriers accompanying those packages.

(d) Mixing of different kinds of packages, including Fissile Class I packages with Fissile Class II packages, is authorized in accordance with § 173.459.

(e) No person shall offer for transportation aboard a passenger-carrying aircraft any single package with a transport index greater than 3.0

or an overpack with a transport index greater than 3.0.

(f) No person shall offer for transportation aboard a passenger carrying aircraft any radioactive material unless that material is intended for use in, or incident to, research, or medical diagnosis or treatment, or is excepted under the provisions of § 175.10 of this subchapter.

(g) If an overpack is used to consolidate individual packages of radioactive materials, the packages shall comply with the packaging, marking, and labeling requirements of this subchapter, and the following:

(1) The overpack shall be labeled as prescribed in § 172.403 of this subchapter except as follows:

(i) the "contents" entry on the label may state "mixed" unless each inside package contains the same radionuclide(s).

(ii) The "number of curies" entry on the label must be determined by adding together the number of curies of the radioactive materials packages contained therein.

(iii) For a non-rigid overpack, the required label together with required package markings shall be affixed to the overpack by means of a securely attached, durable tag. The transport index shall be determined by adding together the transport indexes of the radioactive materials packages contained therein.

(iv) For a rigid overpack, the transport index shall be determined by—

(A) Adding together the transport indexes of the radioactive materials packages contained in the overpack; or

(B) Except for fissile radioactive materials, direct measurements as prescribed in § 173.403(bb) which have been taken by the person initially offering the packages contained within the overpack for shipment.

(2) The overpack shall be marked as prescribed in Subpart D of Part 172 of this subchapter and § 173.25(a).

(3) The transport index of the overpack shall not exceed 3.0 for passenger-carrying aircraft shipments, or 10.0 for cargo-only aircraft shipments.

§ 173.451 Fissile materials—general requirements.

(a) Except as provided in § 173.453, each package containing fissile radioactive materials must comply with §§ 173.451 through 173.459.

§ 173.453 Fissile materials—exceptions.

The requirements of §§ 173.451 through 173.459 do not apply to—

(a) A package containing not more than 15 grams of fissile radionuclides. If

the material is transported in bulk, the quantity limitation applies to the conveyance;

(b) A package containing irradiated natural or depleted uranium including the products of irradiation if the irradiation has taken place only in the thermal reactor;

(c) A package containing homogeneous solutions or mixtures where:

(1) The minimum ratio of the number of hydrogen atoms to the number of atoms of fissile radionuclides (H/X) is 5200;

(2) The maximum concentration of fissile radionuclides is 5 grams per liter; and

(3) The maximum mass of fissile radionuclides in the package is 500 grams, except for a mixture where the total mass of plutonium and uranium-233 does not exceed 1% of the mass of uranium-235 the limit is 800 grams. If the material is transported in bulk, the quantity limitations apply to the conveyance;

(d) A package containing uranium enriched in uranium-235 to a maximum of 1% by weight, and with a total plutonium and uranium-233 content of up to 1% of the mass of uranium-235, if the fissile radionuclides are distributed homogeneously throughout the package contents, and do not form a lattice arrangement within the package;

(e) A package containing any fissile material if it does not contain more than 5 grams of fissile radionuclides in any 10-liter volume, and if the material is packaged so as to maintain this limit of fissile radionuclide concentration during normal transport;

(f) A package containing not more than one kilogram of plutonium of which not more than 20% by mass may consist of plutonium-239, plutonium-241, or any combination of those radionuclides;

(g) A package containing liquid solutions of uranyl nitrate enriched in uranium-235 to a maximum of 2% by weight, with total plutonium and uranium-233 not more than 0.1% of the mass of uranium-235; or

(h) A package containing thorium or uranium with not more than 0.72% by weight of fissile material used for shipment solely within the United States.

§ 173.455 Classification of fissile materials packages.

(a) Except as provided in § 173.453, each package of fissile materials shall be classified as follows:

(1) *Fissile Class I.* Packages that may be transported in unlimited number, and in any arrangement, and that require no nuclear criticality safety controls during

transportation. A transport index is not assigned to Fissile Class I packages for the purposes of nuclear criticality safety control, although, the external radiation levels may require a transport index number.

(2) *Fissile Class II.* Packages that may be transported together in any arrangement but in numbers that do not exceed an aggregate transport index of 50. For the purposes of nuclear criticality safety control, individual packages may have a transport index of not less than 0.1 and not more than 10. However, the external radiation levels may require a higher transport index number. These shipments require no nuclear criticality safety control by the shipper during transportation.

(3) *Fissile Class III.* Shipments of packages of fissile materials that do not meet the requirements of Fissile Class I or Fissile Class II and that are controlled in transportation as prescribed in § 173.457 by appropriate arrangements between the shipper and the carrier.

(b) The numerical values for package assignments as Fissile Class I, the transport indexes for Fissile Class II packages, and the vehicle limitations for Fissile Class III shipments shall be determined in accordance with 10 CFR Part 71.

§ 173.457 Transportation of Fissile Class III shipments—specific requirements.

(a) Fissile Class III shipments shall incorporate transportation controls which are performed by the shipper or carrier, as appropriate, and which:

(1) Provide nuclear criticality safety;

(2) Protect against loading, storing, or transporting that shipment with any other fissile material; and

(3) Include in the shipping papers the description required by § 172.203(d) of this subchapter.

(b) Fissile Class III shipments shall be transported:

(1) In a transport vehicle assigned to the exclusive use of the shipper with a specific restriction for the exclusive use to be provided in the appropriate arrangements between shipper and carrier and with instructions to that effect issued with the shipping papers;

(2) Except for shipments by aircraft, with an escort in a vehicle having the capability, equipment, authority, and instructions to provide administrative controls necessary to assure compliance with this section;

(3) In a transport vehicle containing no other packages of radioactive material that are required to bear one of the labels prescribed in § 172.403 of this subchapter. Specific arrangements must be made between the shipper and the

carrier, with instructions to that effect issued with the shipping papers; or

(4) Under any other procedure specifically authorized by the Associate Director for HMR in accordance with Part 107 of this subchapter.

§ 173.459 Mixing of fissile material packages.

Shipments of fissile materials packages and the commingling of fissile materials packages with other radioactive materials packages shall be in accordance with the provisions of this section.

(a) Mixing of fissile material packages with other types of radioactive materials, including Fissile Class I with Fissile Class II packages is authorized if the total transport index in any transport vehicle or storage location does not exceed 50.

(b) For Fissile Class II packages shipped under the exclusive use provisions of § 173.441(b), the transport index number which is calculated for nuclear criticality control purposes shall not exceed 10 for any single package nor a total of 50 for the load.

(c) Fissile Class II packages may be shipped with an external radiation level greater than 10 millirem per hour at 1 meter (3.3 feet), and combined with other packages of the same or different designs in a Fissile Class III shipment, under the conditions prescribed in § 173.457, if:

(1) Each package in the shipment has been assigned a transport index for criticality control purposes in accordance with the Fissile Class II criteria;

(2) The transport index which has been assigned in the package approval for nuclear criticality control purposes does not exceed 10 for any single package;

(3) The total transport index for nuclear criticality control purposes does not exceed 100 for all packages in the shipment;

(4) The shipment complies with § 173.441(b); and

(5) The shipment is not transported by vessel.

(d) A Fissile Class III shipment of packages may be combined with other packages of the same or different design when each package has been assigned a transport index for nuclear criticality control purposes in accordance with Fissile Class II criteria, and may be combined with Fissile Class II packages into a Fissile Class III shipment under the conditions prescribed in § 173.457, if:

(1) The transport index which has been assigned in the package approval for nuclear criticality control purposes

does not exceed 50 for any single package;

(2) The total transport index for nuclear criticality control purposes for all packages in the shipment does not exceed 100;

(3) The shipment satisfies the provisions of § 173.441(b) if any package has a radiation level exceeding 10 millirem per hour at 1 meter (3.3 feet) from any accessible external surface of the package; and.

(4) The shipment is not transported by vessel.

§ 173.461 Demonstration of compliance with tests.

(a) Compliance with the test requirements in §§ 173.463 through 173.469 shall be shown by any of the methods prescribed in this paragraph, or by a combination of these methods appropriate for the particular feature being evaluated:

(1) By performance of tests with prototypes or samples of the packaging as normally presented for transportation, in which case the contents of the packaging for the test shall simulate as closely as practicable the expected normal radioactive contents;

(2) By reference to a previous, satisfactory demonstration of compliance of a sufficiently similar nature;

(3) By performance of tests with models of appropriate scale incorporating those features that are significant with respect to the item under investigation, when engineering experience has shown results of those tests to be suitable for design purposes. When a scale model is used, the need for adjusting certain test parameters, such as the penetrator diameter or the compressive load, must be taken into account; or

(4) By engineering evaluation or comparative data.

(b) With respect to the initial conditions for the tests under §§ 173.463 through 173.469, except for the water immersion tests, compliance shall be based upon the assumption that the package is in equilibrium at an ambient temperature of 38°C (100°F).

§ 173.462 Preparation of specimens for testing.

(a) Each specimen (i.e., sample, prototype or scale model) shall be examined before testing to identify and record faults or damage, including:

(1) Divergence from the specifications or drawings;

(2) Defects in construction;

(3) Corrosion or other deterioration; and

(4) Distortion of features.

(b) Any deviation found under paragraph (a) of this section from the specified design shall be corrected or suitably taken into account in the subsequent evaluation.

(c) The containment system of the packaging shall be clearly specified.

(d) The external features of the specimen shall be clearly identified so that reference may be made to any part of it.

§ 173.463 Packaging and shielding—testing for integrity.

After each of the applicable tests specified in § 173.465 and § 173.466, the integrity of the packaging, or of the packaging and its shielding, shall be retained to the extent required by § 173.412(m) for the packaging being tested.

§ 173.465 Tests for proposed packagings designed for normal conditions of transportation.

(a) The proposed packaging must be capable of withstanding the tests prescribed in this section. One prototype may be used for all tests if the requirements of paragraph (b) of this section are complied with.

(b) *Water spray test.* The water spray test must precede each test or test sequence prescribed in this section. The water spray test shall simulate exposure to rainfall of approximately 5 centimeters (2 inches) per hour for at least one hour. The time interval between the end of the water spray test and the beginning of the next test shall be such that the water has soaked-in to the maximum extent without appreciable drying of the exterior of the specimen. In the absence of evidence to the contrary, this interval may be assumed to be two hours if the water spray is applied from four different directions simultaneously. However, no time interval may elapse if the water spray is applied from each of the four directions consecutively.

(c) *Free drop test.* The free drop test consists of a fall onto the target in a manner that causes maximum damage to the safety features being tested, and:

(1) For packages weighing 5,000 kilograms (11,000 pounds) or less, the distance of the fall measured from the lowest point of the packaging to the upper surface of the target shall not be less than 1.2 meters (4 feet).

(2) For packages weighing more than 5,000 kilograms (11,000 pounds), the distance of the fall shall not be less than the distance specified in Table 11, for the applicable packaging weight:

TABLE 11.—FREE-FALL DISTANCE FOR PACKAGINGS WEIGHING MORE THAN 5,000 KILOGRAMS

Packaging weight		Free-fall distance	
Kilograms	Pounds	Feet	Meters
5,000 to 10,000.....	11,000 to 22,000....	3	0.9
10,000 to 15,000....	22,000 to 33,000....	2	0.6
More than 15,000...	More than 33,000...	1	0.3

(3) For Fissile Class II packagings, the free drop specified in subparagraph (1) or (2) of this paragraph shall be preceded by a free drop from a height of .3 meter (1 foot) on each corner. For cylindrical packagings, the .3 meter (1 foot) drop shall be onto each of the quarters of each rim.

(4) For fiberboard or wood rectangular packages not exceeding 50 kilograms (110 pounds) in weight, a separate specimen of the proposed packaging shall be subjected to a free drop onto each corner from a height of .3 meter (1 foot).

(5) For fiberboard cylindrical packages weighing not more than 100 kilograms (220 pounds) a separate specimen of the proposed packaging shall be subjected to a free drop onto each of the quarters of each rim from a height of .3 meter (1 foot).

(6) The target shall have a flat, horizontal surface of such mass and rigidity that any increase in its resistance to displacement or deformation upon impact by the specimen would not significantly increase the damage to the specimen.

(d) *Compression test.* The compression test shall last for a period of at least 24 hours and consists of a compressive load equivalent to the greater of the following:

(1) Five times the weight of the actual package; or

(2) 1300 kilograms per square meter (225 pounds per square foot) multiplied by the vertically projected area of the package. The compressive load shall be applied uniformly to two opposite sides of the packaging specimen, one of which must be the base on which the package would normally stand.

(e) *Penetration test.* For the penetration test the packaging specimen shall be placed on a rigid, flat, horizontal surface that will not move while the test is being performed. The test shall consist of:

(1) A bar of 3.2 centimeters (1.25 inches) in diameter with a hemispherical end, weighing 6 kilograms (13.2 pounds) being dropped with its longitudinal axis vertical, onto the center of the weakest part of the packaging specimen, so that, if it penetrates far enough, it will hit the

containment system. The bar must not be deformed by the test; and

(2) The distance of the fall of the bar measured from its lower end to the upper surface of the packaging specimen shall not be less than 1 meter (3.3 feet).

§ 173.466 Additional tests for Type A packagings designed for liquids and gases.

(a) In addition to the tests prescribed in § 173.465, Type A packagings designed for liquids and gases shall be capable of withstanding the following tests:

(1) *Free drop test.* The packaging specimen shall fall onto the target in a manner which will cause it to suffer the maximum damage to its containment. The distance of the fall measured from the lowest part of the packaging specimen to the upper surface of the target shall be not less than 9 meters (30 feet).

(2) *Penetration test.* The specimen must be subjected to the test specified in § 173.465(e) except that the distance of the fall shall be 1.7 meters (5.5 feet).

§ 173.467 Tests for demonstrating the ability of Type B and fissile radioactive materials packagings to withstand accident conditions in transportation.

Each Type B packaging or packaging for fissile material shall meet the test requirements prescribed in 10 CFR Part 71 for ability to withstand accident conditions in transportation.

§ 173.469 Tests for special form radioactive materials.

(a) Special form radioactive materials must meet the test requirements of paragraph (b) of this section. Each solid radioactive material or capsule specimen to be tested shall be manufactured or fabricated so that it is representative of the actual solid material or capsule which will be transported with the proposed radioactive content duplicated as closely as practicable. Any differences between the material to be transported and the test material shall be taken into account. In addition:

(1) A different specimen may be used for each of the tests;

(2) The specimen must not break or shatter when subjected to the impact, percussion, or bending tests;

(3) The specimen must not melt or disperse when subjected to the heat test; and

(4) After each test, leaktightness or indispersibility of the specimen shall be determined by a method no less sensitive than the leaching assessment prescribed in paragraph (c) of this section. For a capsule resistant to corrosion by water, and which has an internal void volume greater than 0.1

milliliters, an alternative to the leaching assessment is a demonstration of leaktightness of 10^{-4} torr-1/s (1.3×10^{-4} atm-cm³/s) based on air at 25°C (77°F) and one atmosphere differential pressure for solid radioactive content, or 10^{-6} torr-1/s (1.3×10^{-6} atm-cm³/s) for liquid or gaseous radioactive content.

(b) Test methods:

(1) *Impact Test.* The specimen must fall onto the target from a height of not less than 9 meter (30 feet). The target must be as specified in § 173.465(c)(6);

(2) *Percussion Test.* (i) The specimen shall be placed on a sheet of lead that is supported by a smooth solid surface, and be struck by the flat face of a steel billet so as to produce an impact equivalent to that resulting from a free fall of 1.4 kilograms (3 pounds) through 1 meter (3.3 feet);

(ii) The flat face of the billet shall be 25 millimeters (1 inch) in diameter with the edges rounded off to a radius of 3 millimeters ± 0.3 millimeters (.12 inch $\pm .012$ inch);

(iii) The lead shall be of a hardness within 3.5 to 4.5 on the Vickers scale, and not more than 25 millimeters (1 inch) thick, and shall cover an area greater than that covered by the specimen;

(iv) A fresh surface to lead shall be used for each impact; and

(v) The billet must strike the specimen in a manner that causes maximum damage.

(3) *Bending test.* (i) This test applies only to long, slender sources with a length of 10 centimeters (4 inches) or more and with a length at least 10 times the minimum width;

(ii) The specimen must be securely clamped in a horizontal position so that one half of its length protrudes from the face of the clamp;

(iii) The position of the specimen must be such that it will suffer maximum damage when its free end is struck by the flat face of a steel billet;

(iv) The billet must strike the specimen in a manner that produces an impact equivalent to that resulting from a free vertical fall of 1.4 kilograms (3 pounds) through 1 meter (3.3 feet); and

(v) The flat face of the billet must be 25 millimeters (1 inch) in diameter with the edges rounded off to a radius of 3 millimeters (.12 inch) ± 0.3 millimeters (.012 inch).

(4) *Heat test.* The specimen shall be heated in air to a temperature of not less than 800°C (1472°F), held at that temperature for a period of 10 minutes, and then allowed to cool.

(c) *Leaching assessment methods.* (1) For indispersible solid material—(i) The specimen shall be immersed for seven days in water at ambient temperature.

The water must have a pH of 6-8 and a maximum conductivity of 10 micromho per centimeter at 20°C (68°F);

(ii) The water and specimen shall then be heated to a temperature of 50°C $\pm 5^\circ$ (122°F $\pm 9^\circ$) and maintained at this temperature for four hours;

(iii) The activity of the water shall then be determined;

(iv) The specimen shall then be stored for at least seven days in still air with humidity not less than 90 percent at 30°C (86°F);

(v) The specimen shall then be immersed in water with the same pH and maximum conductivity specifications as in subparagraph (1)(i) of this paragraph. The water and specimen must be heated to 50°C $\pm 5^\circ$ (122°F $\pm 9^\circ$) and maintained at that temperature for four hours;

(vi) The activity of the water shall then be determined. The activities determined in subparagraph (1)(iii) and this subparagraph shall not exceed 0.05 microcuries.

(2) For encapsulated material—(i) The specimen shall be immersed in water at ambient temperature. The water must have a pH of 6-8 and a maximum conductivity of 10 micromho per centimeter. The water and specimen shall be heated to a temperature of 50°C $\pm 5^\circ$ (122°F $\pm 9^\circ$) and maintained at this temperature for four hours;

(ii) The activity of the water shall then be determined;

(iii) The specimen shall then be stored for at least seven days in still air at a temperature not less than 30°C (86°F);

(iv) Step (i) shall be repeated; and

(v) The activity of the water shall be determined. The activities determined in paragraph (c)(2)(ii) and this paragraph (c)(2)(v) shall not exceed 0.05 microcuries.

§ 173.471 Requirements for U.S. Nuclear Regulatory Commission approved packages.

In addition to the applicable requirements of the U.S. Nuclear Regulatory Commission (USNRC) and Parts 171-177 of this subchapter, any shipper of a Type B or fissile material package that has been approved by the USNRC in accordance with 10 CFR Part 71 shall also comply with the following requirements:

(a) The shipper shall be registered with the USNRC as a party to the approval, and the shipment must be made in compliance with the terms of the approval;

(Approved by the Office of Management and Budget under OMB control number 2137-0512)

(b) The outside of each package shall be durably and legibly marked with the package identification marking indicated in the USNRC approval;

(c) Each shipping paper related to the shipment of the package shall bear the package identification marking indicated in the USNRC approval;

(d) Before the first export shipment of the package, the shipper shall obtain a U.S. Competent Authority Certificate for that package design or if one has already been issued, the shipper shall register with the U.S. Competent Authority as a user of the certificate. Upon registration as a user of the certificate the shipper will be furnished with a copy of it. The shipper shall then submit a copy of the U.S. Competent Authority Certificate applying to that package design to the national competent authority of each country into or through which the package will be transported, unless a copy has already been furnished;

(Approved by the Office of Management and Budget under OMB control numbers 2137-0514 and 2137-0515)

(e) The U.S. Competent Authority responsible for administering the requirements of Section VIII of the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)," is the—

Materials Transportation Bureau, Office of Hazardous Materials Regulation (OHMR), U.S. Department of Transportation, Washington, D.C. 20590.

(f) Each request for a U.S. Competent Authority Certificate as required by the IAEA regulations shall be submitted in writing to the address set forth in paragraph (e) of this section. The request shall be in duplicate and include copies of the applicable USNRC approval and a reproducible drawing showing the make-up of the package. Each request is considered in the order in which it is received. To allow sufficient consideration by OHMR, requests should be received at least 45 days before the requested effective date; and

(Approved by the Office of Management and Budget under OMB control number 2137-0514)

(g) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

§ 173.472 Requirements for exporting DOT specification Type B and fissile packages.

(a) Any shipper who exports a DOT specification Type B or fissile material package authorized by §§ 173.416 or

173.417 shall comply with paragraphs (b) through (f) of this section.

(b) The shipper shall register with the U.S. Competent Authority as a user of the appropriate U.S. Competent Authority Certificate and the shipment shall be made in accordance with the certificate;

(Approved by the Office of Management and Budget under OMB control number 2137-0515)

(c) The outside of each package must be durably and legibly marked with the package identification marking indicated in the U.S. Competent Authority Certificate;

(d) Each shipping paper related to the shipment of the package must bear the package identification marking indicated in the U.S. Competent Authority Certificate;

(e) Before the first export shipment of the package, the shipper must submit a copy of the U.S. Competent Authority Certificate applying to that package design to the national competent authority of each country into or through which the package will be transported, unless a copy has already been furnished; and

(Approved by the Office of Management and Budget under OMB control number 2137-0515)

(f) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

§ 173.473 Requirements for foreign-made packages.

In addition to the applicable requirements of Parts 171 through 177 of this subchapter, each shipper of a foreign-made Type B or fissile material package for which a competent authority certificate is required by the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)" shall also comply with the following requirements:

(a) Prior to the first shipment of such a package of radioactive materials into or from the U.S., the shipper shall:

(1) Have the foreign competent authority certificate revalidated by the U.S. Competent Authority, unless this has been done previously. The request must be in duplicate and contain all the information required by Section VIII of the IAEA regulations. Each request is considered in the order in which it is received. To allow sufficient consideration by OHMR, requests should be received at least 45 days before the requested effective date.

(2) Submit a copy in English of the foreign competent authority certificate with the request for revalidation;

(3) Register its identity in writing with the U.S. Competent Authority as a user of the package covered by the foreign competent authority certificate and its revalidation. If the shipper is requesting the revalidation, this is automatically done by OHMR; and

(4) Supply to the carrier, upon request, the applicable competent authority certificates. However, the competent authority certificates are not required to accompany the packages to which they apply.

(Approved by the Office of Management and Budget under OMB control number 2137-0517.)

(b) The outside of each package shall be durably and legibly marked with the same competent authority identification marking indicated on the competent authority certificate and revalidation;

(c) Each shipping paper for a shipment of radioactive materials shall bear a notation of the package identification marking indicated on the competent authority certificate or revalidation; and

(d) Import and export shipments may be made in accordance with § 171.12 of this subchapter.

§ 173.474 Quality control for construction of packaging.

(a) Prior to the first use of any packaging for the shipment of radioactive material, the shipper shall determine, that—

(1) The packaging meets the quality of design and construction requirements as specified in this subchapter; and

(2) The effectiveness of the shielding, containment, and, when required, the heat transfer characteristics of the package, are within the limits specified for the package design.

§ 173.475 Quality control requirements prior to each shipment of radioactive materials.

Before each shipment of any radioactive materials package, the shipper shall ensure by examination or appropriate tests, that—

(a) The packaging is proper for the contents to be shipped;

(b) The packaging is in unimpaired physical condition, except for superficial marks;

(c) Each closure device of the packaging, including any required gasket, is properly installed, secured, and free of defects;

(d) For fissile material, each moderator and neutron absorber, if required, is present and in proper condition;

(e) Each special instruction for filling, closing, and preparation of the

packaging for shipment has been followed;

(f) Each closure, valve, or other opening of the containment system through which the radioactive content might escape is improperly closed and sealed;

(g) Each packaging containing liquid in excess of an A_2 quantity and intended for air shipment has been tested to show that it will not leak under an ambient atmospheric pressure of not more than 0.25 atmosphere, absolute, (0.25 kilograms per square centimeter or 3.8 psia). The test must be conducted on the entire containment system, or on any receptacle or vessel within the containment system, to determine compliance with this requirement;

(h) The internal pressure of the containment system will not exceed the design pressure during transportation; and

(i) External radiation and contamination levels are within the allowable limits specified in this subchapter.

§ 173.476 Approval of special form radioactive materials.

(a) Each shipper of special form radioactive materials shall maintain on file for at least one year after the latest shipment, and provide to the MTB on request, a complete safety analysis, including documentation of any tests, demonstrating that the special form material meets the requirements of § 173.469.

(Approved by the Office of Management and Budget under OMB control number 2137-0516.)

(b) Prior to the first export shipment of a special form radioactive material from the United States, each shipper shall obtain a U.S. Competent Authority Certificate for the specific material. Each petition shall be submitted in accordance with § 173.471(e) and must include the following information:

(1) A detailed description of the material or if a capsule, a detailed description of the contents. Particular reference must be made to both physical and chemical states;

(2) If a capsule is to be used, a detailed statement of its design and dimensions, including complete engineering drawings and schedules of material, and methods of construction; and

(3) A statement of the tests that have been made and their results; evidence based on calculative methods to show that the material is able to pass the tests; or other evidence that the special form radioactive material complies with § 173.469.

(Approved by the Office of Management and Budget under OMB control number 2137-0518.)

(c) Paragraphs (a) and (b) of this section do not apply in those cases where A_1 equals A_2 and the material is not described on the shipping papers as "Radioactive Material Special Form, n.o.s."

§ 173.477 Approval for export shipments.

(a) Each export shipment of a package for which an IAEA certificate of competent authority has been issued or revalidated in accordance with §§ 173.471, 173.472, or 173.473 shall have multilateral approval, if the shipment includes—

(1) A vented Type B(M) package;

(2) A Type B(M) packaging containing radioactive materials with an activity greater than $3 \times 10^3 A_1$, or $3 \times 10^3 A_2$, as appropriate, or 3×10^4 curies, whichever is less;

(3) A Fissile Class III shipment; or

(4) Transportation by special arrangement.

(b) Each application for shipment approval shall contain—

(1) The period of time for which the approval is sought;

(2) A description of the contents, the expected modes of transportation, the type of vehicle to be used, and the proposed route; and

(3) An explanation of how the special precautions and special administrative and operational controls referred to in the package design certificates are to be put into effect.

(c) The packaging and shipment approvals may be combined into a single approval issued in accordance with §§ 173.471, 173.472 or 173.473.

(d) Approval by competent authorities is not required for packagings designed for materials covered by §§ 173.421 through 173.427 nor for Type A packagings designed for non-fissile radioactive materials.

§ 173.478 Notification to competent authorities for export shipments.

(a) Before the first export shipment of any packaging with contents exceeding A_1 or A_2 , the shipper shall ensure that copies of each applicable competent authority certificate issued in accordance with §§ 173.471, 173.472, or 173.473 have been submitted to the competent authority of each country through which or into which it is to be transported. The shipper is not required to await an acknowledgment from the competent authority prior to shipping the radioactive material, nor is the competent authority required to acknowledge receipt of the certificate.

(Approved by the Office of Management and Budget under OMB control number 2137-0515.)

(b) For each of the shipments described in this paragraph, the shipper shall notify the competent authority of each country through which or into which the shipment is to be transported. This notification must be received by each competent authority at least 15 days before the shipment starts for the following:

(1) Type B(U) packagings containing radioactive materials with an activity greater than $3 \times 10^3 A_1$, $3 \times 10^3 A_2$, as appropriate, or 3×10^4 curies, whichever is the least;

(2) Type B(M) packages;

(3) Fissile Class III shipments under Section VIII of the IAEA "Regulations for the Safe Transport of Radioactive Materials, Safety Series No. 6, 1973 Revised Edition (as amended)"; or

(4) Transportation by special arrangements.

(c) The shipper notification must include—

(1) Sufficient information to enable the packaging to be identified, including all applicable certificate numbers and identification marks; and

(2) Information as to the date of shipment, the expected date of arrival, and the proposed routing.

(d) The shipper is not required to send a separate notification if the required information has been included in the application for shipment approval.

PART 174—CARRIAGE BY RAIL

§ 174.208 [Amended]

14a. In § 174.208, paragraph (b) is amended by removing section reference "173.426" and inserting, in its place, "173.9".

15. In § 174.700, paragraph (a) is amended by removing section reference "§ 173.389(c) and § 173.392" and inserting in their respective places "§§ 173.403 and 173.425"; paragraph (b) is amended by removing section reference "§ 173.389(j)" and inserting in its place "§ 173.403(bb)"; and by removing section references "§§ 173.389(o) and 173.392, 173.393(j), or 173.396(f)" and inserting in their respective places "§§ 173.403, 173.425, 173.441, and 173.457"; paragraph (d) is amended by removing section references "§ 173.389(a)(3) and § 173.396(g)" and inserting in their respective places "§ 173.455(a)(3) and § 173.457"; and a new paragraph (g) is added to read as follows:

§ 174.700 Special handling requirements for radioactive materials.

(g) In the case of packages shipped under the exclusive use provisions of § 173.441(b) for packages with external radiation levels in excess of 200 millirem per hour at the package surface:

(1) The rail car shall meet the requirements for a closed transport vehicle (§ 173.403 of this subchapter); and

(2) Provisions must be made to secure the packages so that their position within the vehicle remains fixed under conditions normally incident to transportation.

§ 174.715 [Amended]

16. In § 174.715, paragraph (a) is amended by removing section reference "§ 173.389(c)" and inserting in its place "§ 173.403"; and by removing section reference "§ 173.397(a)" and inserting in its place "§ 173.443".

§ 174.750 [Amended]

17. In § 174.750, paragraph (a) is amended by removing section reference "§ 173.397" and inserting in its place "§ 173.443."

PART 175—CARRIAGE BY AIRCRAFT**§ 175.710 [Amended]**

18. In § 175.10, paragraph (a)(6) is amended by removing section reference "§ 173.391 (a), (b), or (c)" and inserting in its place "§§ 173.421, 173.422, or 173.424."

19. In § 175.700, the section heading is revised; paragraph (b) is amended by removing section reference "§ 173.397" and inserting in its place "§ 173.443"; paragraph (c) is amended by removing section reference "§ 173.391 (a), (b), or (c)" and inserting in its place "§§ 173.421, 173.422, or 173.424"; and a new paragraph (d) is added to read as follows:

§ 175.700 Special limitations and requirements for radioactive materials.

(d) Type B(M) packages may not be offered or accepted for transportation, nor transported, on passenger-carrying aircraft.

20. In § 175.703, paragraph (b) is amended by removing section reference "§ 173.393(r)" and inserting in its place "§ 173.448(g)"; paragraph (c) is amended by removing section reference "§ 173.389(a)(3)" and inserting in its place "§ 173.455(a)(3)"; and paragraphs (d) and (e) are added to read as follows:

§ 175.703 Other special requirements for the acceptance and carriage of packages containing radioactive materials.

(d) No person may offer or accept for transportation, nor transport, by air:

(1) Any Type B(U) or Type B(M) package with an accessible surface temperature in excess of 50°C (122°F);

(2) Continuously vented Type B(M) packages, packages which require external cooling by an ancillary cooling system or packages subject to operational controls during transport; or

(3) Liquid pyrophoric radioactive materials.

(e) Exclusive use shipments of packages having a surface radiation level in excess of 200 millirem per hour may not be transported by air except by special arrangement approved by MTB.

PART 176—CARRIAGE BY VESSEL

21. In Part 176, Subpart M is revised to read as follows:

Subpart M—Detailed Requirements for Radioactive Materials

Sec.

176.700 General stowage requirements.

176.704 Requirements relating to transport.

176.708 Segregation distance table.

176.710 Care following leakage or sifting of radioactive materials.

176.715 Contamination control.

Subpart M—Detailed Requirements for Radioactive Materials**§ 176.700 General stowage requirements.**

(a) Radioactive materials must not be stowed in the same hold with mail bags.

(b) A package of radioactive materials which in still air has a surface temperature more than 5°C (9°F) above the ambient air may not be overstored with any other cargo. If the package is stowed under deck, the hold or compartment in which it is stowed must be ventilated.

(c) Each Fissile Class III shipment must be stowed in a separate hold, compartment, or defined deck area and be separated by a distance of at least six meters (20 feet) from all other Radioactive Category II or III—Yellow labeled packages. For a shipment of radioactive materials requiring supplemental operational procedures, the shipper must furnish the master or person in charge of the vessel a copy of the necessary operational instructions.

(Paperwork requirement excepted from Office of Management and Budget approval)

(d) A person may not remain unnecessarily in a hold or compartment or in the immediate vicinity of any package on deck containing radioactive materials.

§ 176.704 Requirements relating to transport indexes.

(a) The sum of the transport indexes for all packages of radioactive materials not in freight container on board a vessel, may not exceed 200.

(b) Except as provided in paragraph (e) of this section, the sum of transport indexes for packages not in a freight container may not exceed 50 in any hold, compartment, or defined deck area. Each group of radioactive material packages must be separated by a distance of at least six meters (20 feet) at all times.

(c) Except as provided in paragraph (e) of this section, the number of freight containers with packages of radioactive materials contained therein must be limited so that the total sum of the transport indexes in the containers in any hold or defined deck area does not exceed 200, and:

(1) The sum of transport indexes for any individual freight container, or group of freight containers, does not exceed 50; and

(2) Each freight container or group of freight containers is handled and stowed in such a manner that groups are separated from each other by a distance of at least six meters (20 feet).

(d) The limitations specified in paragraphs (a), (b), and (c) of this section do not apply to consignments of low specific activity materials if the packages are marked "RADIOACTIVE LSA" and no Fissile Class II or Fissile Class III radioactive materials are included in the shipment.

(e) For exclusive use shipments, the limitations specified in paragraphs (b) and (c) of this section do not apply if—

(1) For packages not in freight containers, the sum of the transport indexes of Fissile Class II packages does not exceed 50 in each hold;

(2) For packages in freight containers, the radiation level does not exceed 200 millirem per hour at any point on the surface and 10 millirem at two meters (6 feet) from the outside surface of the freight container and the sum of transport indexes of Fissile Class II packages does not exceed 50 in each freight container and 200 in each hold or defined deck area; and

(3) Each group of Fissile Class II packages is separated from other radioactive material by a distance of at least six meters (20 feet) at all times.

(f) The limitations specified in paragraphs (a) through (e) of this section do not apply when the entire vessel is reserved or chartered for use by a single shipper under exclusive use conditions if the number of Fissile Class II and Fissile Class III packages of radioactive

materials aboard the vessel does not exceed the amount authorized in §§ 173.451 through 173.459 of this subchapter. The entire shipment operation must be approved by the Office of Hazardous Materials Regulation (OHMR) in advance.

§ 176.708 Segregation distance table.

(a) Table III applies to the stowage of packages of radioactive materials on board a vessel with regard to transport index numbers which are shown on the labels of individual packages. Radioactive Category II or III-Yellow labeled packages may not be stowed any closer to living accommodations,

regularly occupied working spaces, spaces that may be continually occupied by any person (except those spaces exclusively reserved for couriers specifically authorized to accompany such packages), and undeveloped film than the distance specified to Table III. Where only one consignment of a radioactive substance is to be loaded on board a vessel under exclusive use conditions, the appropriate segregation distance may be established by demonstrating that the direct measurement of the radiation level at regularly occupied working spaces and living quarters is less than 0.75 millirem per hour. More than one consignment

may be loaded onboard a vessel with the appropriate segregation distance established by demonstrating that direct measurement of the radiation level at regularly occupied working spaces and living quarters is less than 0.75 millirem per hour, provided that the vessel has been chartered for the exclusive use of a competent person specialized in the carriage of radioactive material. Stowage arrangements shall be predetermined for the entire voyage, including any radioactive substances to be loaded at ports of call enroute. The radiation level shall be measured by a responsible person skilled in the use of monitoring instruments.

TABLE III

Sum of transport indexes of the packages	Minimum distance in feet from living accommodation or regularly occupied working space	Minimum distance in feet from undeveloped film and plates																			
		1 day voyage		2 day voyage		4 day voyage		10 day voyage		20 day voyage		30 day voyage		40 day voyage		50 day voyage					
Cargo thickness in feet (unit density)																					
0.1 to 0.5	Nil	3	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil	3	6	Nil
0.6 to 1	5	X	6	X	X	8	X	X	11	X	X	17	4	X	25	6	X	30	7	X	35
1.1 to 2	6	X	8	X	X	11	X	X	16	4	X	25	6	X	35	8	X	42	10	X	50
2.1 to 3	9	X	11	X	X	16	4	X	22	5	X	35	8	X	50	12	X	61	14	X	70
3.1 to 5	10	X	14	X	X	19	5	X	27	6	X	42	10	X	61	14	X	74	18	X	86
5.1 to 10	13	X	17	4	X	25	6	X	35	8	X	55	13	X	78	19	X	96	23	X	110
10.1 to 20	19	4	25	6	X	35	8	X	50	12	X	78	19	X	110	26	X	135	33	8	155
20.1 to 30	26	6	35	8	X	50	12	X	69	17	X	110	26	X	155	37	9	190	46	11	220
30.1 to 50	32	8	43	10	X	61	14	X	85	20	X	135	32	8	190	45	11	235	56	13	270
50.1 to 100	42	10	55	13	X	78	19	X	110	26	X	175	42	10	245	58	14	300	73	17	350
100.1 to 150	59	14	78	19	X	110	26	X	155	37	9	245	59	14	350	82	20	430	105	24	515
150.1 to 200	72	17	96	23	X	135	32	8	190	46	11	300	72	17	425	100	24	525	125	30	600
	84	20	110	26	X	155	37	9	200	53	13	350	84	20	490	115	28	600	140	35	(7)
200.1 to 300	105	24	135	32	X	190	46	11	270	64	15	425	105	25	600	145	35	(7)	180	42	(7)
300.1 to 400	120	28	160	37	9	220	53	13	310	75	18	500	120	28	(7)	165	40	(7)	205	49	(7)

Note:

- (1) X—indicates that thickness of screening cargo is sufficient without any additional segregation distance.
- (2) By using 6 feet of intervening unit density cargo for persons and 10 feet for film and plates, no distance shielding is necessary for any length of voyage specified.
- (3) Using 1 steel bulkhead or steel deck—multiply segregation distance by 0.8. Using 2 steel bulkheads or steel decks—multiply segregation distance by 0.64.
- (4) "Cargo of Unit Density" means cargo stowed at a density of 1 ton (long) per 36 cubic feet; where the density is less than this the depth of cargo specified must be increased in proportion.
- (5) "Minimum distance" means the least in any direction whether vertical or horizontal from the outer surface of the nearest package.
- (6) The total consignment on board at any time must not exceed transport indexes totalling 200 except if carried under the provisions of § 176.704(f). The figures below the double line of the table should be used in such a contingency.
- (7) Not to be carried unless screening by other cargo and bulkheads can be arranged in accordance with the other columns.

Sum of transport indexes of the packages	Minimum distance in meters from living accommodation or regularly occupied working space	Minimum distance in meters from undeveloped film and plates																					
		1 day voyage		2 day voyage		4 day voyage		10 day voyage		20 day voyage		30 day voyage		40 day voyage		50 day voyage							
Cargo thickness in meters (unit density)																							
	Nil	1	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2	Nil	1	2
0.1 to 0.5	2	X	2	X	X	3	X	X	4	X	X	6	2	X	8	2	X	10	3	X	11	3	X
0.6 to 1.0	2	X	3	X	X	4	X	X	5	2	X	8	2	X	11	3	X	13	4	X	15	4	X
1.1 to 2.0	3	X	4	X	X	5	2	X	7	2	X	11	3	X	15	4	X	19	5	X	22	5	X
2.1 to 3.0	4	X	5	X	X	6	2	X	9	2	X	13	4	X	19	5	X	23	6	X	27	7	X
3.1 to 5.0	4	X	6	2	X	8	2	X	11	3	X	17	4	X	24	6	X	30	7	X	34	8	X
5.1 to 10.0	6	2	8	2	X	11	3	X	15	4	X	24	6	X	34	8	X	42	10	3	48	12	3
10.1 to 20.0	8	2	11	3	X	15	4	X	22	5	X	34	8	X	48	12	3	59	14	4	68	16	4
20.1 to 30.0	10	3	13	4	X	19	5	X	26	7	X	42	10	3	59	14	4	72	17	4	83	20	5

Sum of transport indexes of the packages	Minimum distance in meters from living accommodation or regularly occupied working space	Minimum distance in meters from undeveloped film and plates															
		1 day voyage		2 day voyage		4 day voyage		10 day voyage		20 day voyage		30 day voyage		40 day voyage		50 day voyage	
30.1 to 50.0	13	3	17	4	X	24	6	X	34	8	X	54	13	3	76	18	5
50.1 to 100.0	18	5	24	6	X	34	8	X	48	12	3	76	18	5	110	25	6
100.1 to 150.0	22	6	30	7	X	42	10	3	59	14	4	83	22	6	130	31	8
150.1 to 200.0	26	6	34	8	X	46	12	3	68	16	4	110	26	7	150	36	9
200.1 to 300.0	32	8	42	10	3	59	14	4	83	20	5	130	32	8	185	44	11
300.1 to 400.0	36	9	46	12	3	68	16	4	95	23	6	150	36	9	(7)	50	13

Note:

- (1) X—indicates that thickness of screening cargo is sufficient without any additional segregation distance.
 (2) By using 2 meters of intervening unit density cargo for persons and 3 meters for film and plates, no distance shielding is necessary for any length of voyage specified.
 (3) Using 1 steel bulkhead or steel deck—multiply segregation distance by 0.8, using 2 steel bulkheads or steel decks—multiply segregation distance by 0.64.
 (4) "Cargo of Unit Density" means cargo stowed at a density of 1 ton (metric) per cubic meter; where the density is less than this the depth cargo specified must be increased in proportion.
 (5) "Minimum distance" means the least in any direction whether vertical or horizontal from the outer surface of the nearest package.
 (6) The total consignment on board at any time must not exceed transport indexes totaling 200, unless carried under the provisions of § 176.704(f). The figures below the double line of the table should be used in such a contingency.
 (7) Not to be carried unless screening by other cargo and bulkheads can be arranged in accordance with the other columns.

§ 176.710 Care following leakage or sifting of radioactive materials.

(a) In case of fire, collision, or breakage involving any shipment of radioactive materials, other than materials of low specific activity, the radioactive materials must be segregated from unnecessary contact with personnel. In case of obvious leakage, or if the inside container appears to be damaged, the stowage area (hold, compartment, or deck area) containing this cargo must be isolated as much as possible to prevent radioactive material from entering any person's body through contact, inhalation, or ingestion. No person may handle the material or remain in the vicinity unless supervised by a qualified person.

(b) A hold or compartment in which leakage of radioactive materials has occurred may not be used for other cargo until it is decontaminated in accordance with the requirements of § 176.715.

(c) For reporting requirements, see § 171.15 of this subchapter.

§ 176.715 Contamination control.

(a) Each hold, compartment, or deck area used for the transportation of low specific activity radioactive materials under exclusive use conditions shall be surveyed with appropriate radiation detection instruments after each use. Such holds, compartments, and deck areas may not be used again until the radiation dose rate at any accessible surface is less than 0.5 millirem per hour, and the removable (non-fixed) radioactive surface contamination is not greater than the limits prescribed in § 173.443 of this subchapter.

PART 177—CARRIAGE BY PUBLIC HIGHWAY**§ 177.825 [Amended]**

21a. In § 177.825, paragraphs (b), (c),

and (d) are amended by removing the phrase "large quantity radioactive material as defined in § 173.389(b)" and inserting in its place "highway route controlled quantity radioactive materials as defined in § 173.403(l)"; and paragraphs (b)(2)(iii) and (d)(2)(iv) are amended by removing the term "large quantity" and inserting in its place "highway route controlled quantity."

22. In § 177.842, paragraph (a) is amended by removing section references "§ 173.389(i), § 173.393(j), § 173.396(f) and § 173.392", and inserting in their respective places "§§ 173.403, § 173.441(b), § 173.457, and § 173.425"; paragraph (c) is amended by removing section references "§ 173.389(c) and § 173.392", and inserting in their respective places "§§ 173.403 and § 173.425"; paragraph (f) is amended by removing section references "§ 173.389(a)(3) and § 173.396(g)", and inserting in their respective places "§§ 173.455(a)(3) and § 173.457"; and paragraph (g) is added to read as follows:

§ 177.842 Radioactive material.

(g) For shipments transported under exclusive use conditions the radiation dose rate must not exceed 2 millirem per hour in any position normally occupied in the vehicle. For shipments transported as exclusive use under the provisions of § 173.441(b) for packages with external radiation levels in excess of 200 millirem per hour at the package surface, the vehicle must meet the requirements of a closed transport vehicle (§ 173.403 of this subchapter).

23. In § 177.843, paragraph (a) is revised to read as follows:

§ 177.843 Contamination of vehicles.

(a) Each motor vehicle used for transporting radioactive materials under exclusive use conditions in accordance with §§ 173.425(c) or 173.443(c) shall be surveyed with radiation detection instruments after each use. A vehicle may not be returned to service until the radiation dose rate at each accessible surface is 0.5 millirem per hour or less and the removable (non-fixed) radioactive surface contamination is not greater than the level prescribed in § 173.443(a).

§ 177.861 [Amended]

24. In § 177.861, paragraph (a) is amended by removing section reference § 173.397 and inserting in its place § 173.443.

Appendix A—[Amended]

24a. In Appendix A, all references to "large quantity" throughout Appendix A are changed to read "highway route controlled quantity".

PART 178—SHIPPING CONTAINER SPECIFICATIONS**§ 178.350-2 [Amended]**

25. In § 178.350-2, paragraph (a) is amended by removing section references "§ 173.389(j) and § 173.398(b)", and inserting in their respective places "§§ 173.403 and § 173.465".

(49 U.S.C. 1803, 1804, 1808; 49 CFR 1.53, App. A, to Part 1)

Issued in Washington, D.C., on February 24, 1983

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[FR Doc. 83-5215 Filed 3-9-83; 8:45 am]

BILLING CODE 4910-60-M